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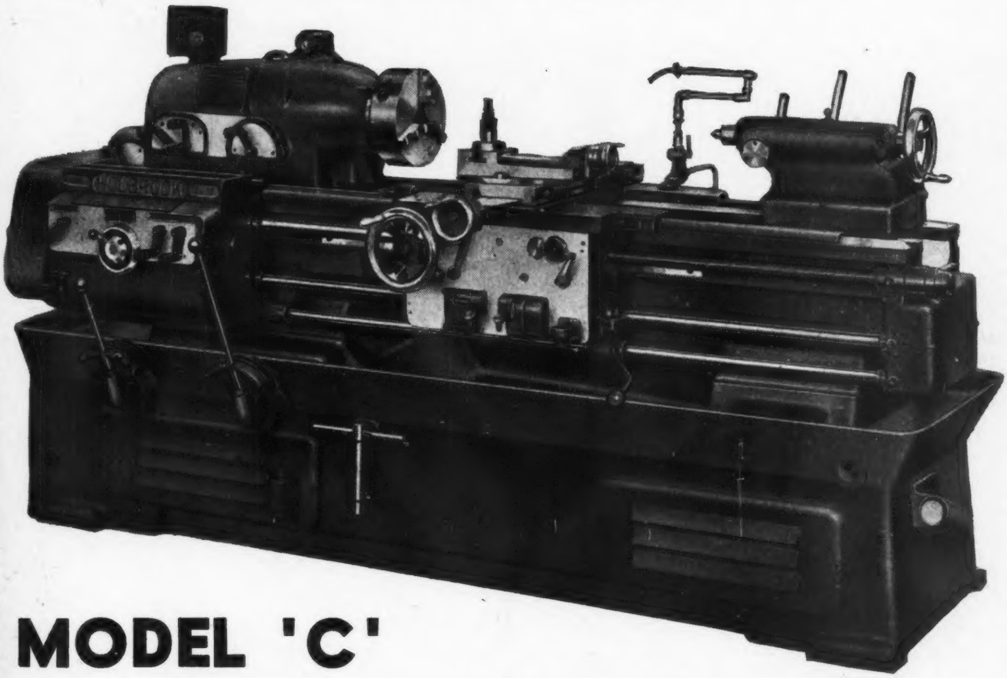

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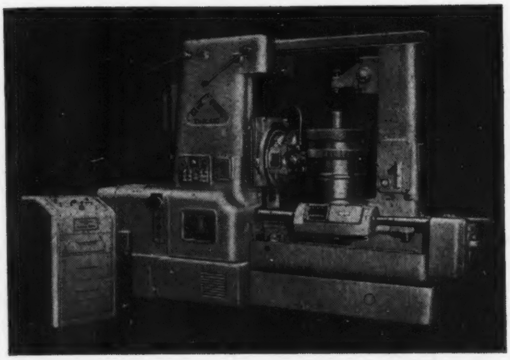
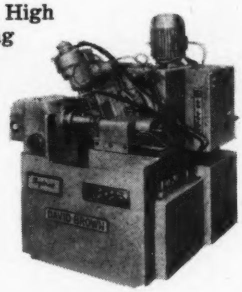
OA/7089B

David Brown precision machine tools for gear production

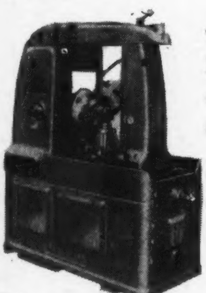


The UPH.30 Ultra Precision Hobbing Machine produces gears up to 30 in. dia. It incorporates electronic accuracy control, measuring accuracy at 30 in. diameter being 0.00015 in.

The design of David Brown precision gear cutting and finishing machines in based on the experience of over 100 years. The range is the widest offered by any one company, and covers all types of production techniques for spur and helical gears up to a size of 18 ft. diameter. The four machines shown are typical of the whole range, in that within their fields, they combine a high degree of accuracy with high production rates. David Brown machines like these are giving fine service in nearly every country of the world.

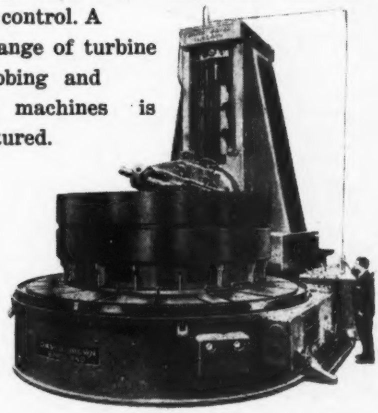


The No. 10 Hydrax High Production Gear Hobbing Machine has a capacity of 10 in. dia. Capable of the fastest known production rates, it is used extensively by the automobile and tractor industries. Complementary Production Gear Shaving Machines are produced.



The MT.15 is one of the MT series machines which cut a wide variety of spur and helical gears, splines and sprockets, from 1 in. to 8 ft. 4 in. dia. They can also produce wormwheels by the tangential feed method.

The range of Turbine Gear Hobbing Machines has capacities up to 18 ft. dia. Of special interest to producers of marine gears where a very high degree of accuracy is essential. This range can also incorporate electronic accuracy control. A similar range of turbine gear hobbing and shaving machines is manufactured.



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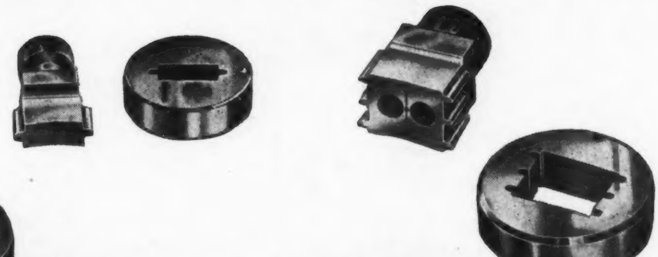

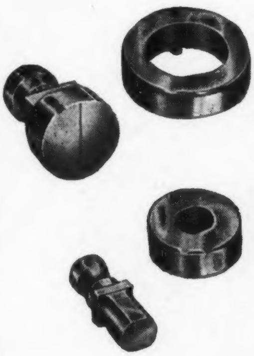

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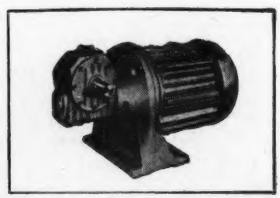
Please write for catalogue V.60 which gives further technical information.



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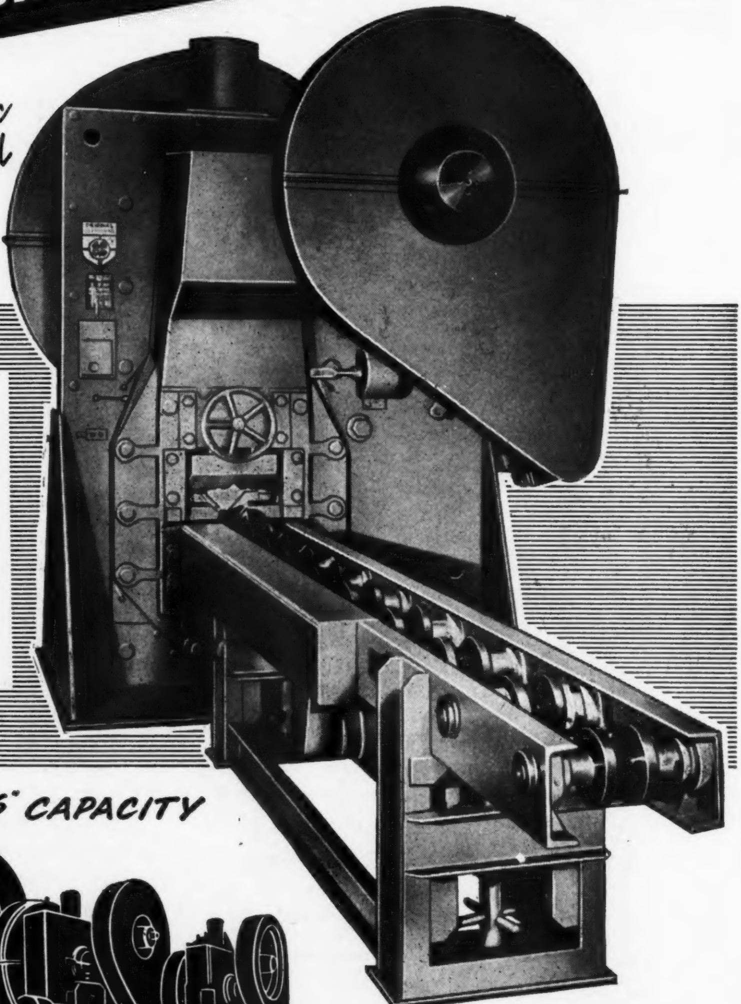
with Automatic hold-down and Automatic feed table



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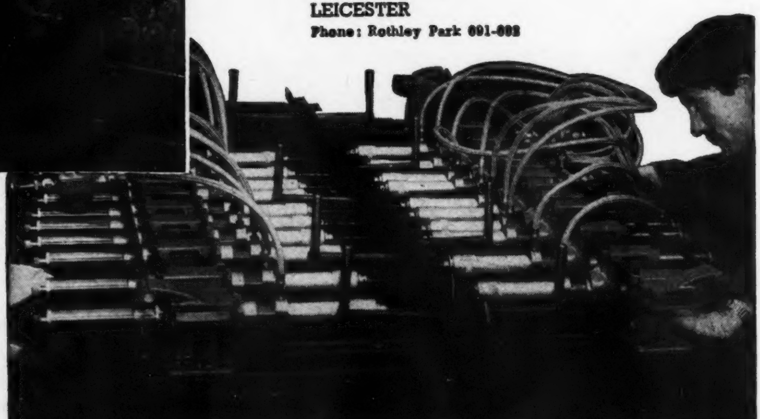

For further details of this unique system write for Leaflet SFM.4

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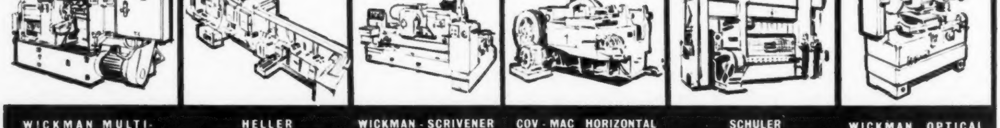
If production is your problem...



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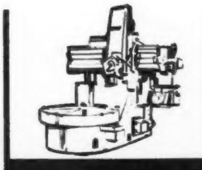
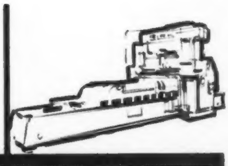


WEBSTER & BENNETT BORING & TURNING MILL



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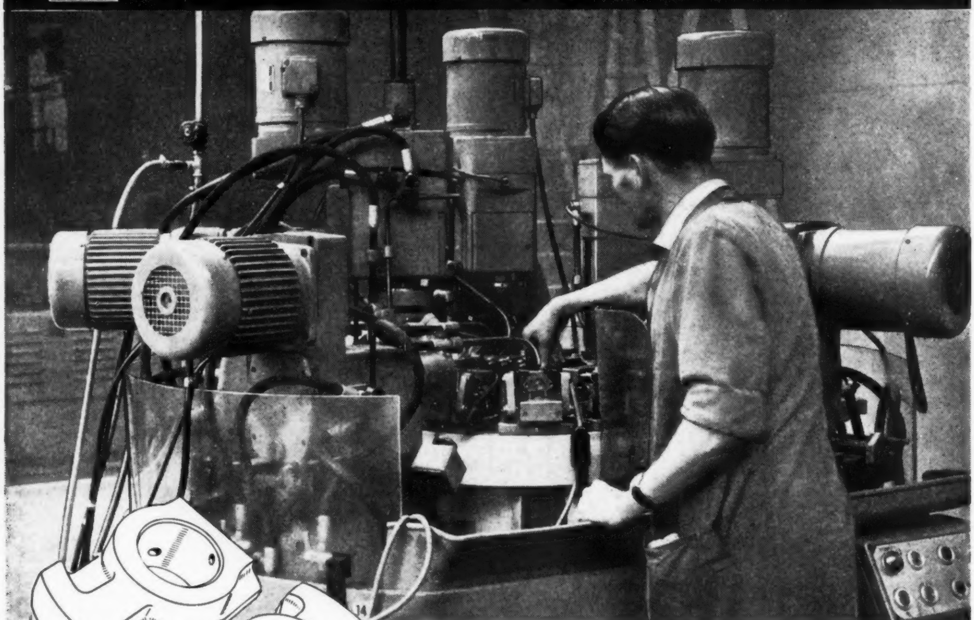
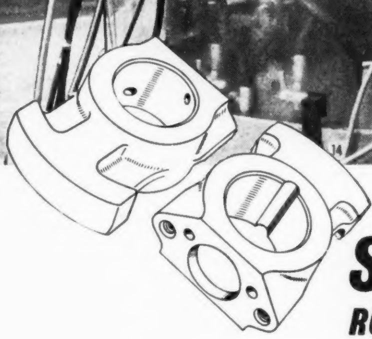
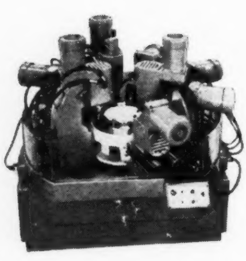




SCHAUBLIN 20
ROTARY TRANSFER MACHINE



Small components requiring a variety of machining operations at mass production rates are most economically produced on the Schaublin 20.

Comprising up to eight individual working stations and as many as eleven motor-driven machining heads, this Swiss-built precision automatic handles turning, milling, drilling, screwing and tapping operations of the most complex character with consummate ease.

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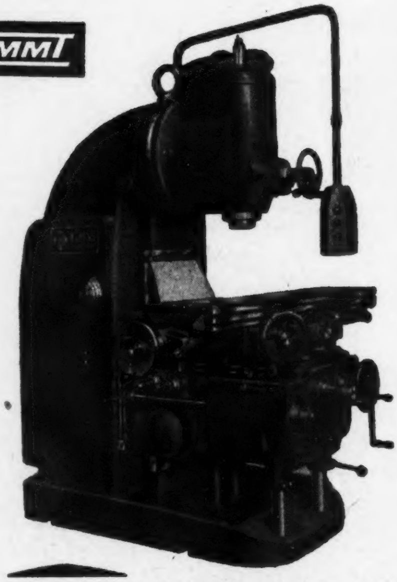

New VF.20 Vertical Milling Machine featuring the swivelling head with independent motor drive for power feed to quill, enabling power feed of quill to be obtained at any angle desired. This is a valuable feature especially in repetitive drilling and boring. Main spindle motor 15 h.p., feed motor 3½ h.p., special feed motor for spindle quill ½ h.p.

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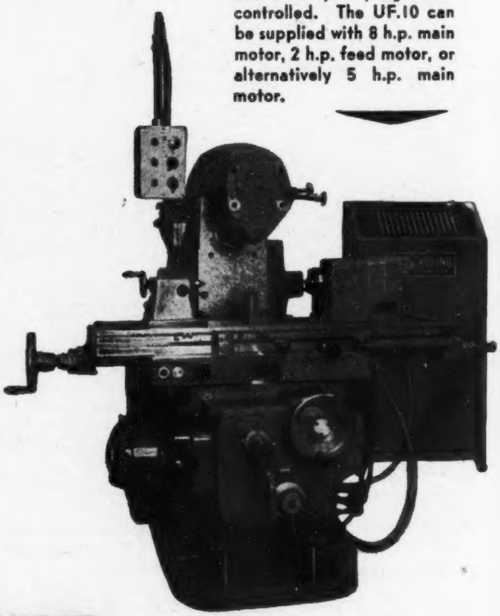

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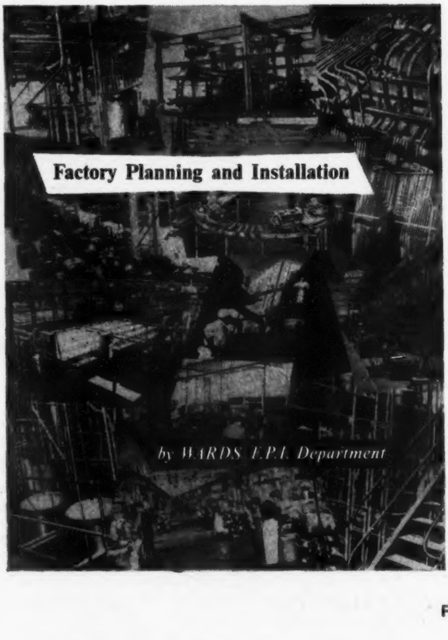

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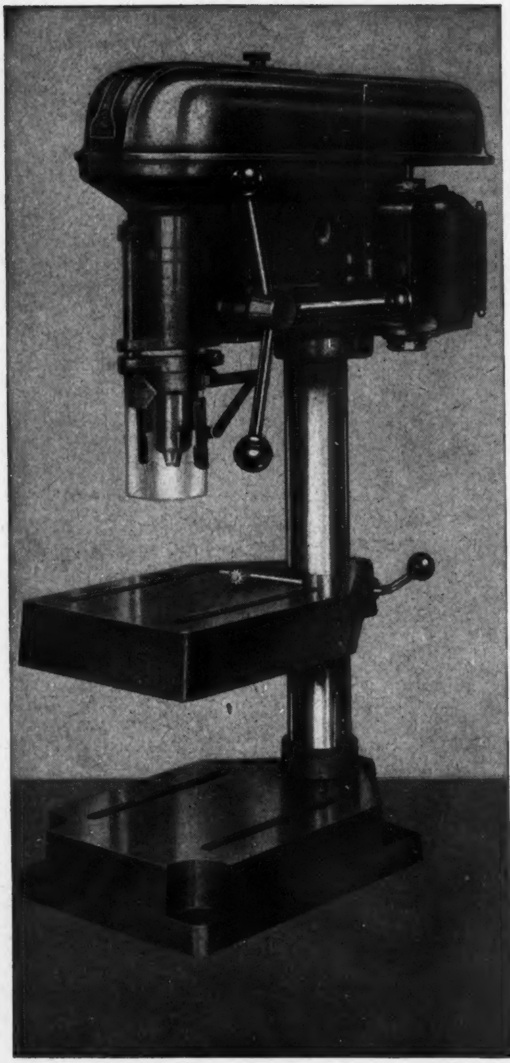

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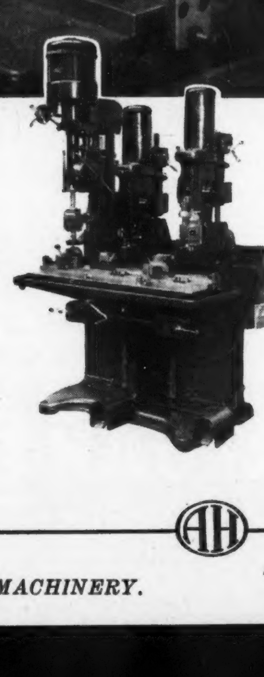

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Herbert All-electric Drilling Machines are made in ten types for drilling holes from the very smallest, at 18,000 r.p.m., up to 1¼" diameter. This equipment meets all general-purpose single or multi-spindle requirements. Unit construction and interchangeability enable special requirements to be easily met. We will quote for machines and equipment to meet special requirements for drilling, tapping and associated operations.

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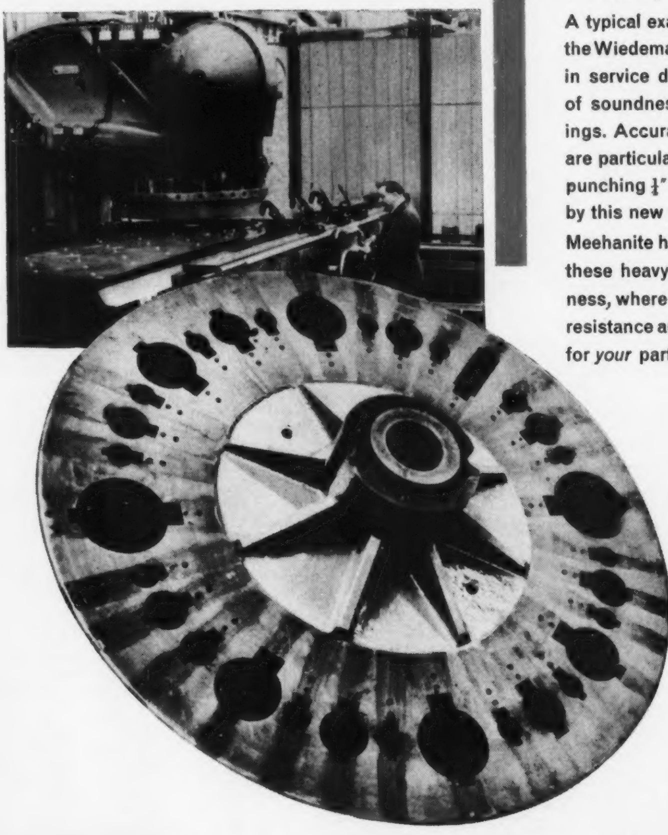

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- **A4 Casting Properties**
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THE INTERNATIONAL MEEHANITE METAL CO., LTD., EPSOM, SURREY

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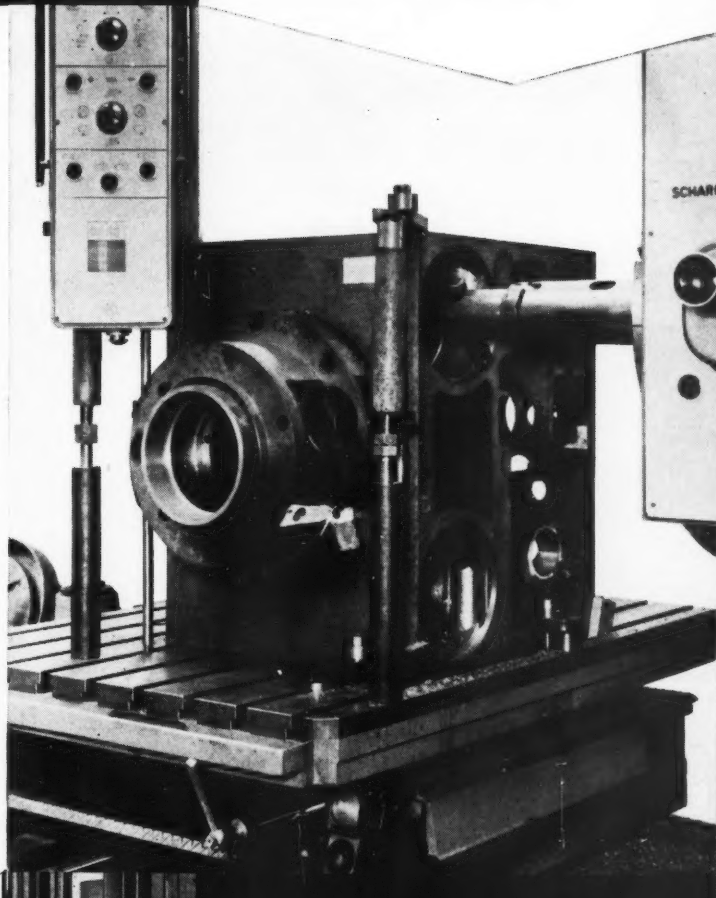
PRECISION BORING & MILLING ✱ THE SCHARMANN OPTICUT 'FB 500 C'



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This universal and horizontal boring machine is optically controlled. It is also a heavy duty milling machine with a large facing capacity.

The Opticut reduces operating time substantially as far less time is required for spacing, resetting and realigning, particularly when engaged on 180° index boring. There is no guesswork—with the Opticut you see everything—the speeds, feeds and settings are readily visible on the pendant. The Scharmann Opticut is extremely accurate—the concentric headstock suspension ensures absolute stability under mechanical stress and varying thermal conditions.

Write today for Booklet 1704-A which fully describes this machine.

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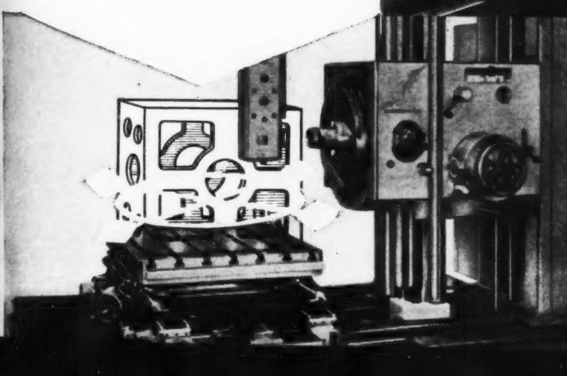

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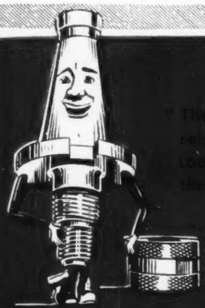

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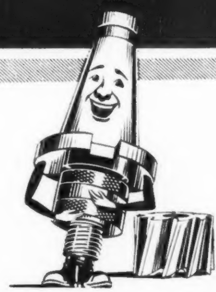
This high-efficiency combination simplifies screw-locked milling and achieves the greatest productivity.

Ease of assembly, precision in performance, and duration of working life, are the outstanding features of the Heli-Matic equipment.

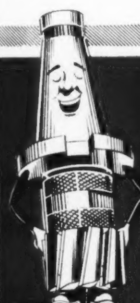
FIRST STAGE

Screw on the nut by hand —as far as it will go.



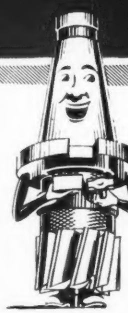
SECOND STAGE

Screw on the cutter to meet the nut then release by a part reverse turn.



THIRD STAGE

Screw back the nut firmly against the cutter by hand—immediately cutting starts the cutter will lock solidly against the nut, making a rigid tool assembly.



TO RELEASE

Apply the spanner to the nut and a few sharp hammer blows will release the nut from the cutter, which can then be screwed off by hand."

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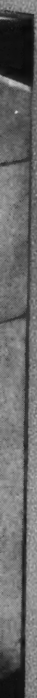


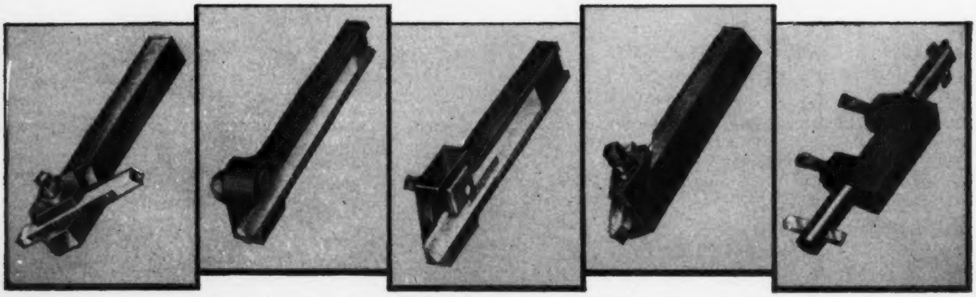
Eclipse

tool bits, lathe tools and tool holders

with many special features

"Eclipse" tool holders are manufactured with the utmost care from high quality materials, are carefully heat treated and incorporate a number of special features which enable them to do their job superbly well.

To complete the list of tools for turning and metal cutting, there is also the extensive range of "Eclipse" tool bits and lathe tools. Made from "Eclipse" H3 cobalt High Speed Steel, these tools are carefully heat treated to give the perfect combination of hardness and toughness — tools which can be relied upon to maintain a keen cutting edge.



"Eclipse" hacksaw blades and other tools are made by James Neill & Co (Sheffield) Ltd., and are obtainable from all tool distributors.

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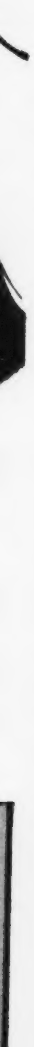

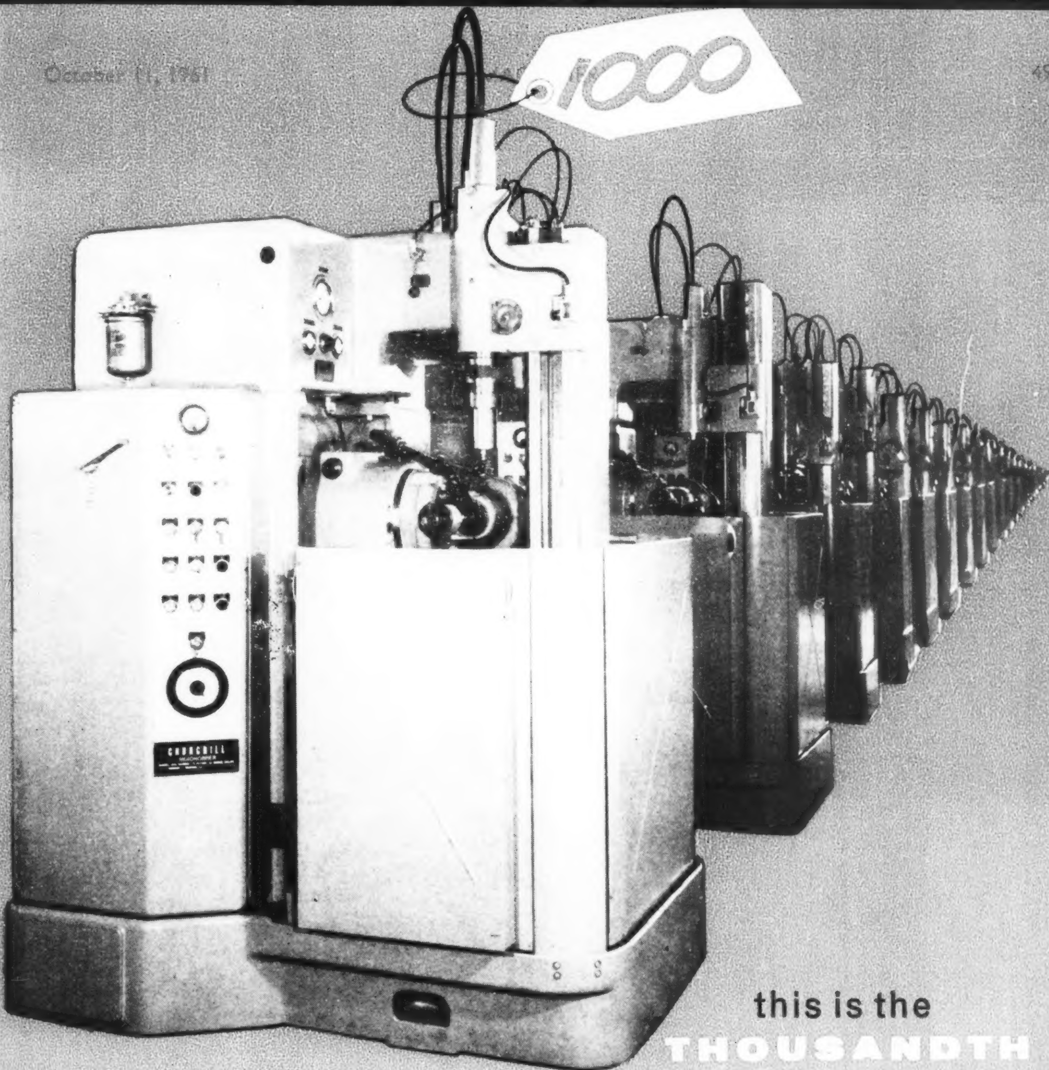
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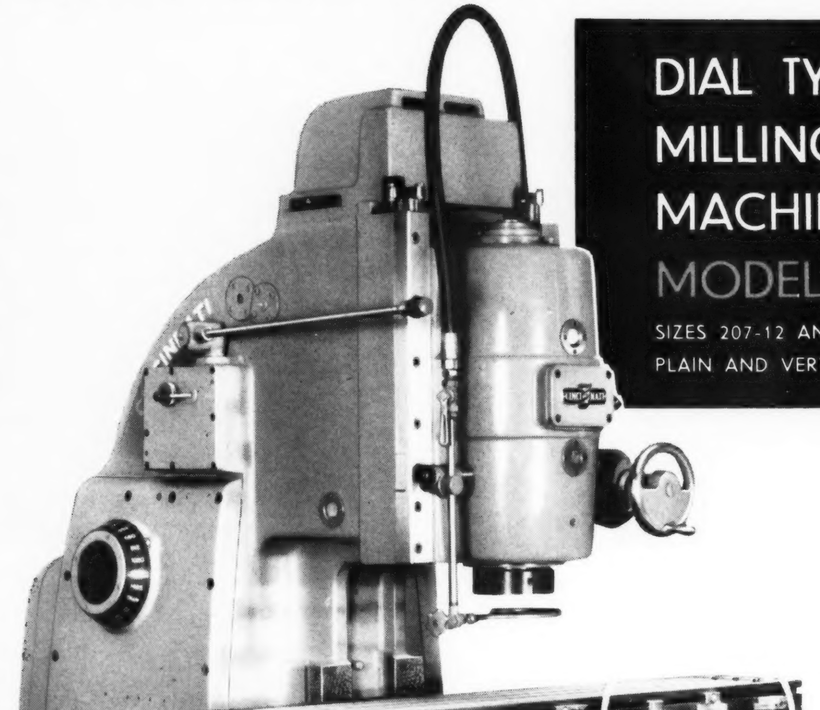
CINCINNATI

DIAL TYPE
MILLING
MACHINES
MODEL 'ELR'

SIZES 207-12 AND 307-12
PLAIN AND VERTICAL



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THE SCIENTIFIC APPROACH

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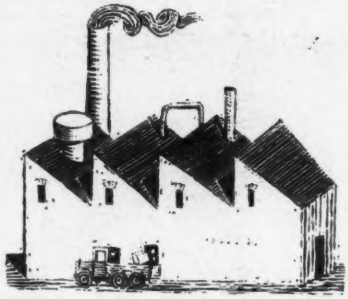

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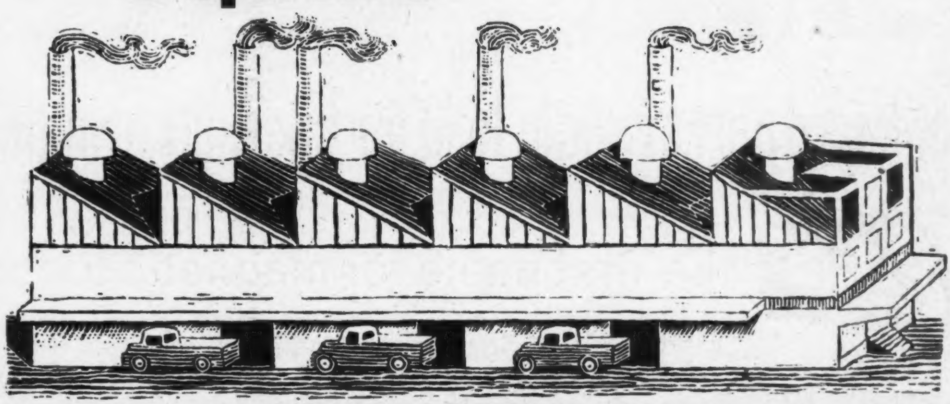

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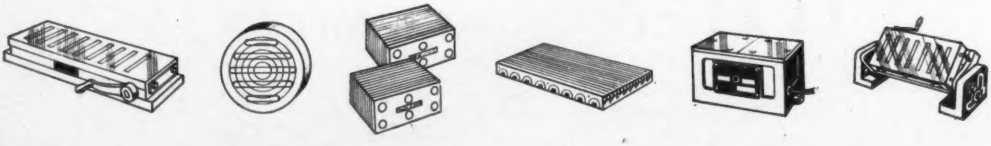

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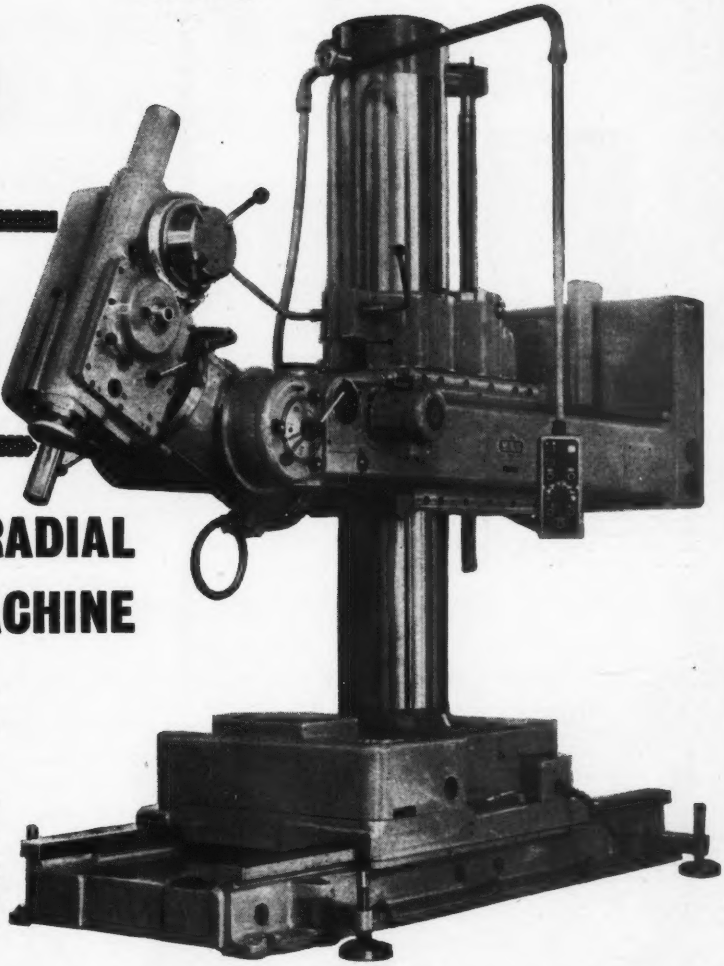

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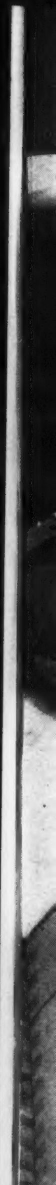

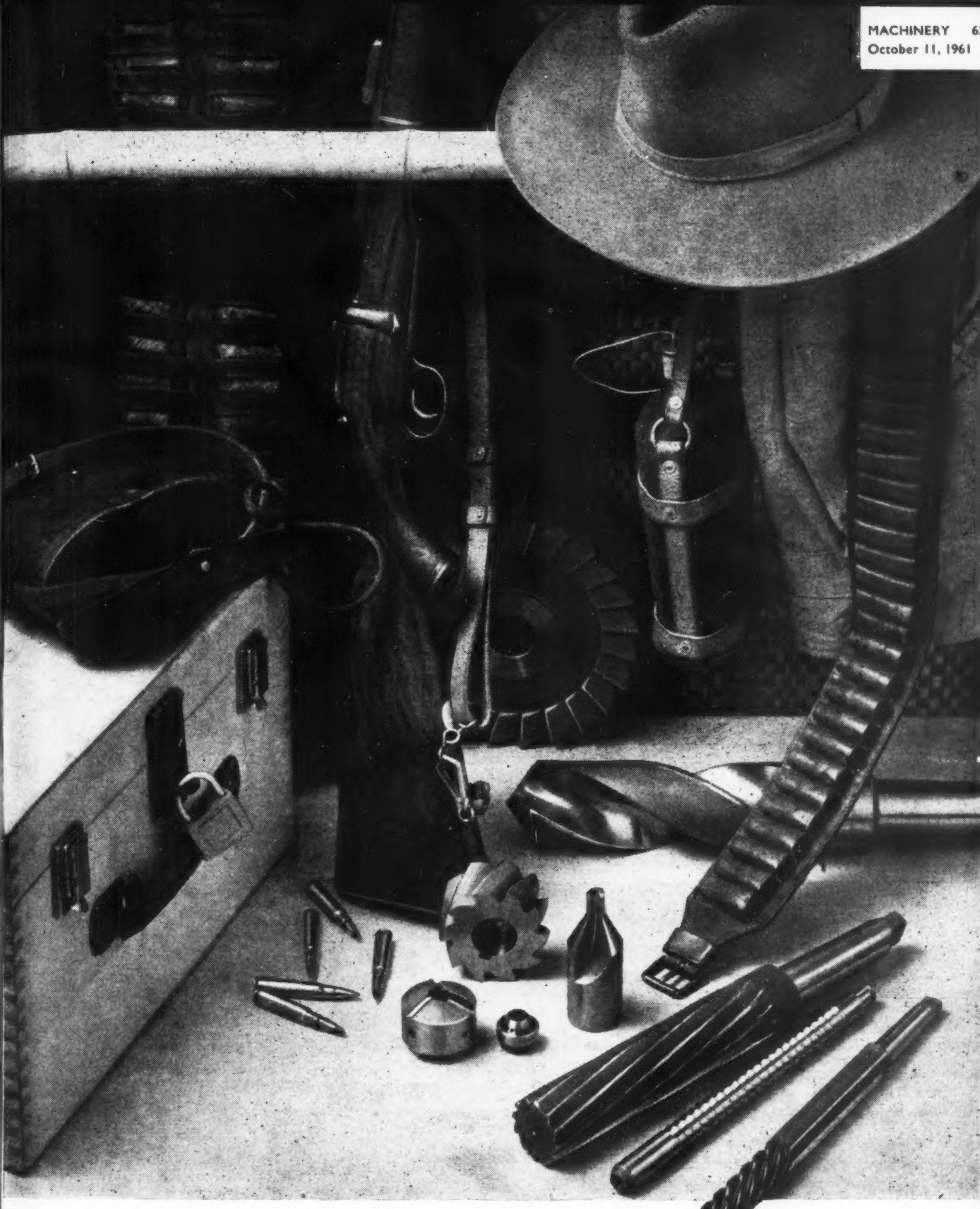

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MEX CAP $18\frac{3}{4}$ in. x $6\frac{1}{4}$ in. x 8 in. (Hydraulic)

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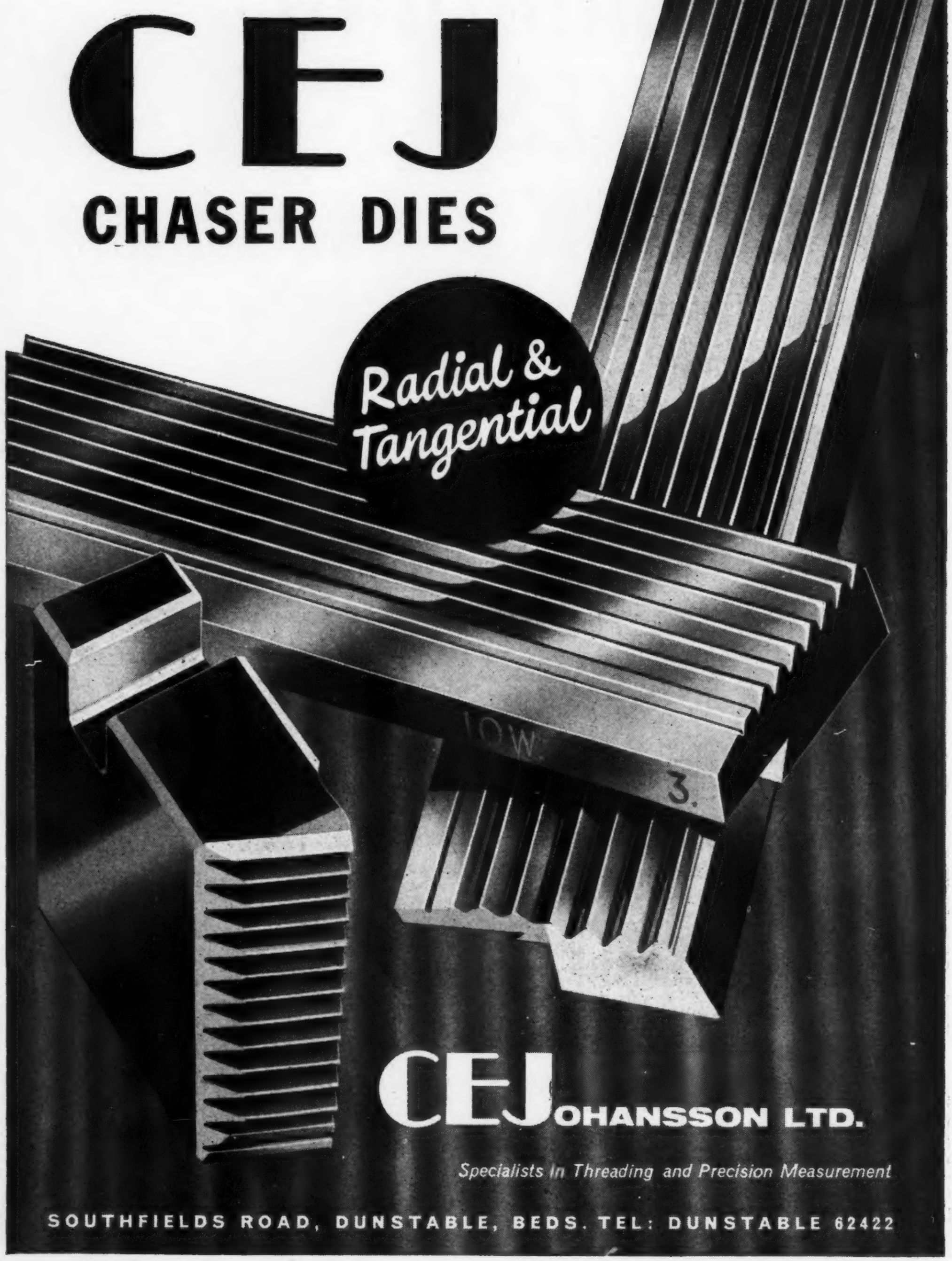
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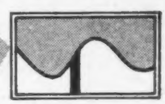
the drawing
the workpiece
the wheel



are all on the same screen on the

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MACHINE
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SIZE RANGE 12" X 24" TO 12" X 72"
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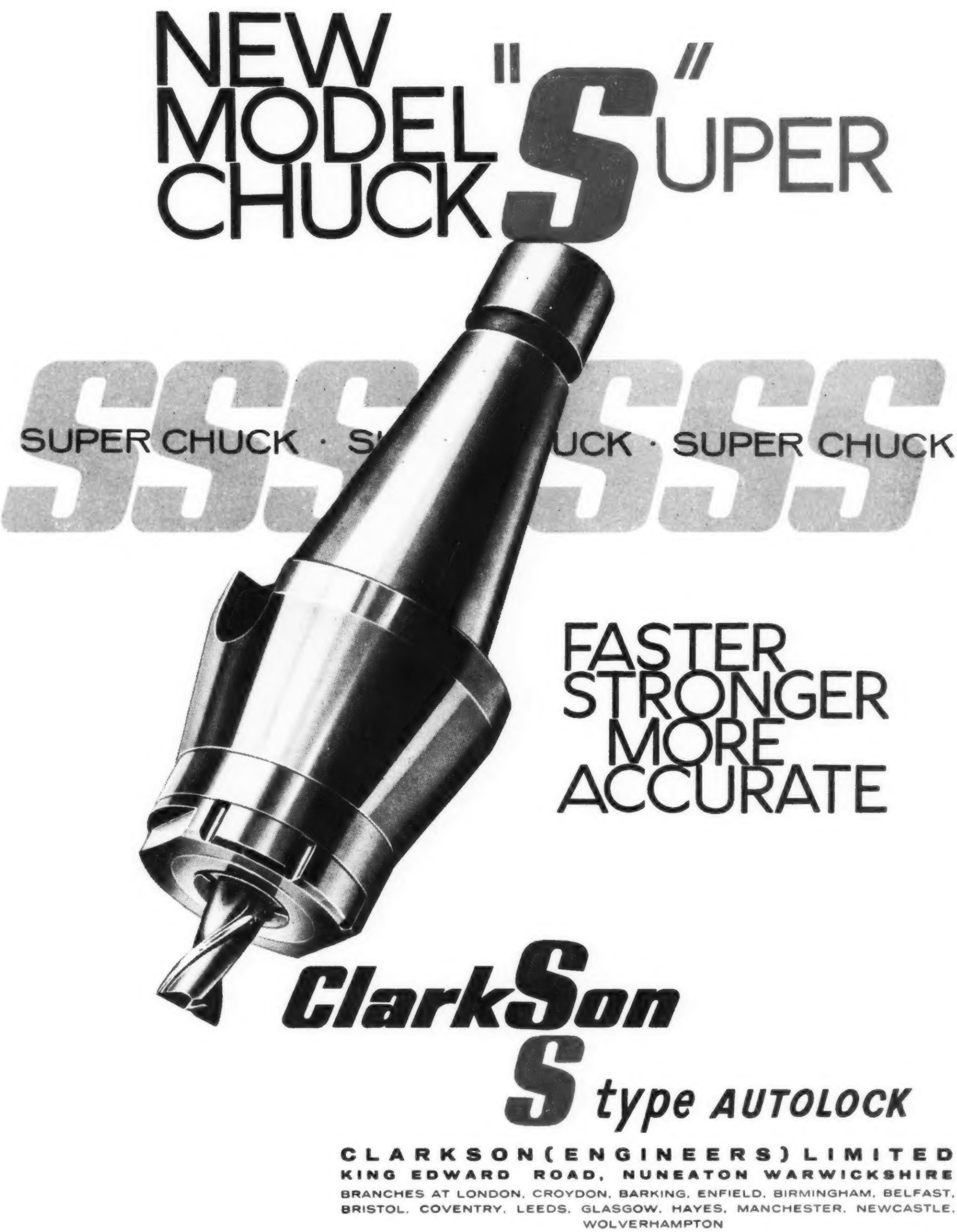
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SUPER CHUCK · SUPER CHUCK · SUPER CHUCK
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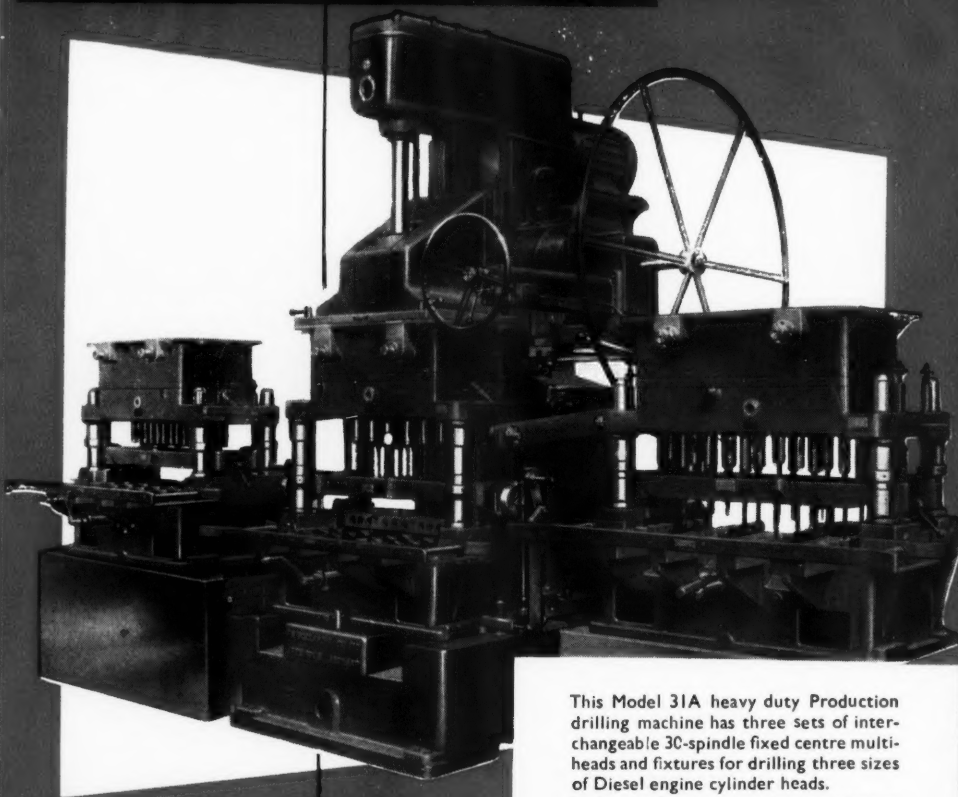
high speed—
heavy duty

PRODUCTION DRILLING

on diesel engine cylinder heads at—F. Perkins Ltd., Peterborough



This Model 31A heavy duty Production drilling machine has three sets of interchangeable 30-spindle fixed centre multi-heads and fixtures for drilling three sizes of Diesel engine cylinder heads.

Eight similar sets are in operation at F. Perkins Ltd., Peterborough. Outstanding amongst the many features of this equipment is great stability, and accuracy of re-location with quick changeovers. Complete changeover in nine minutes.

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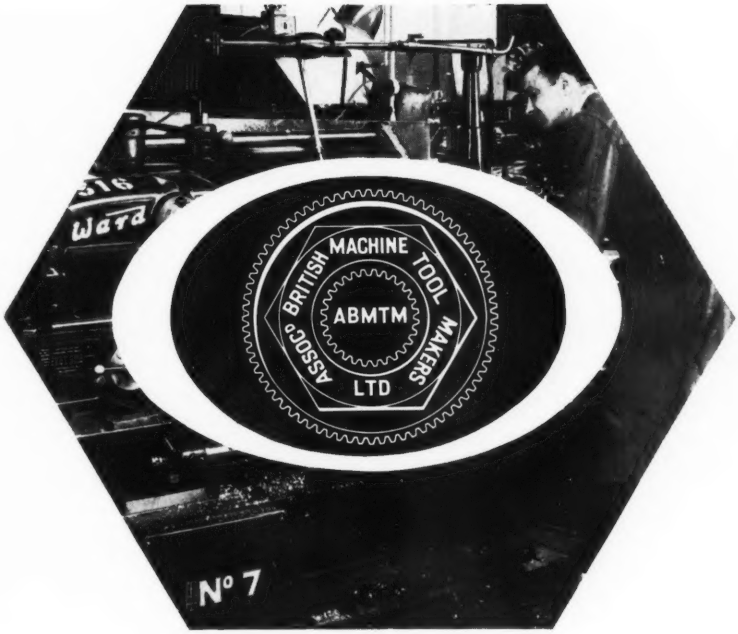

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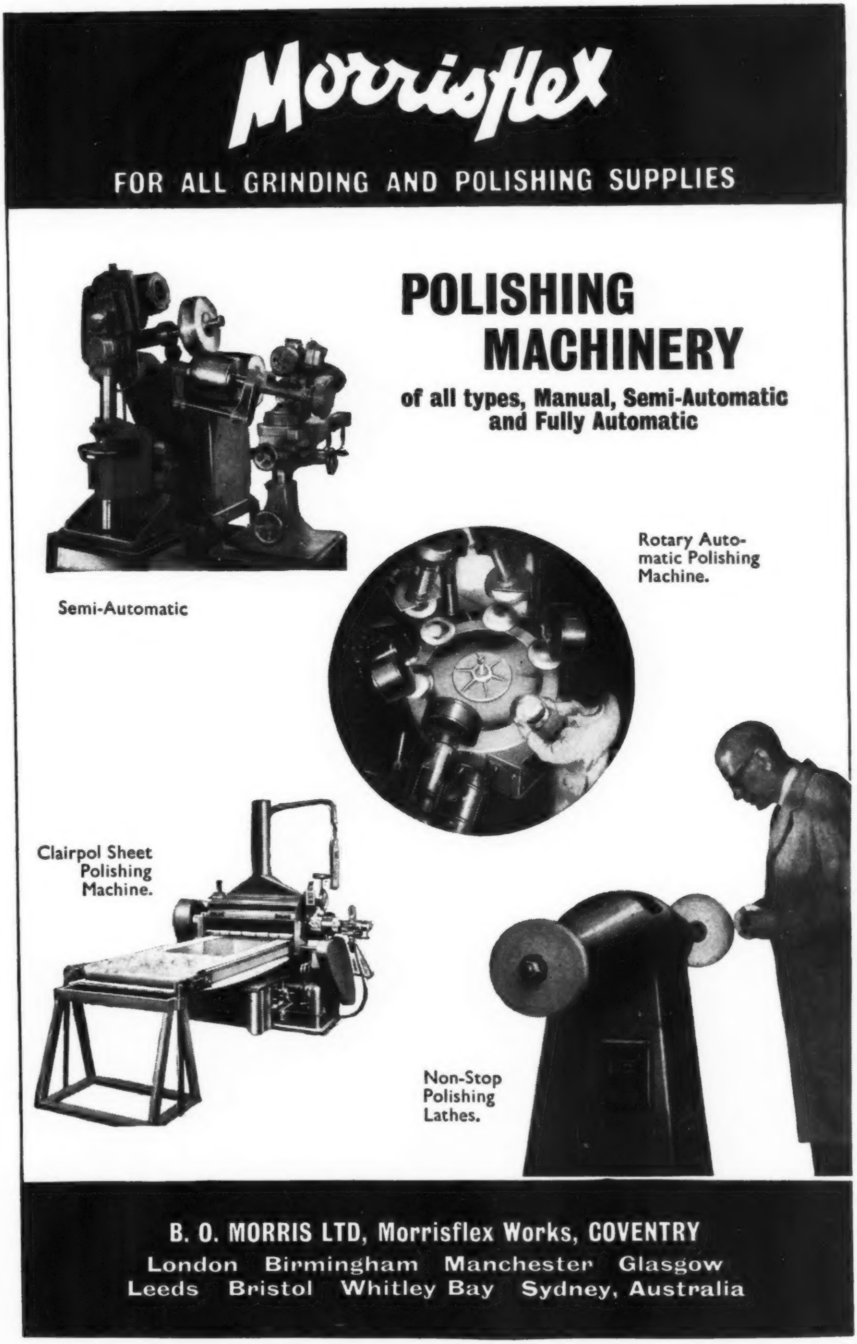
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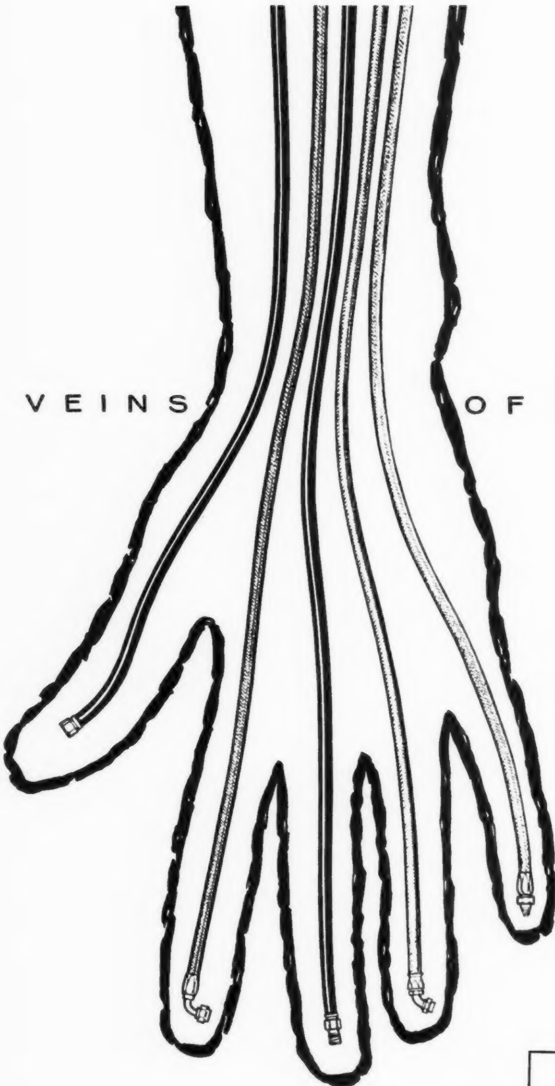

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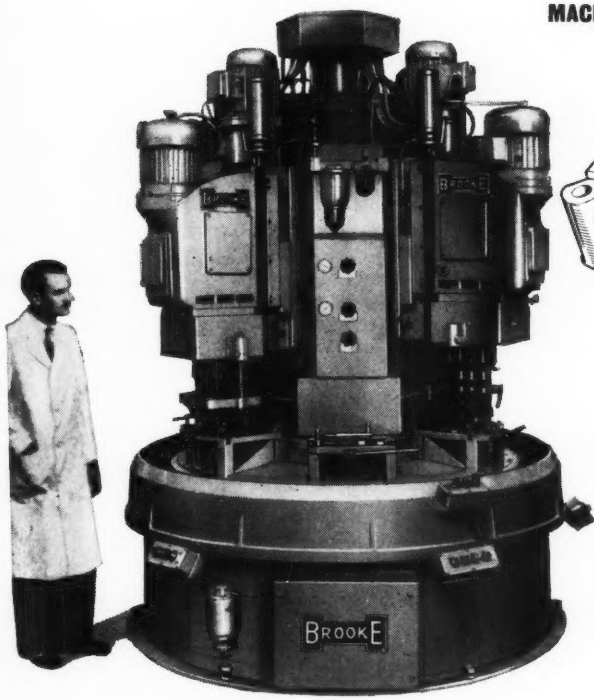
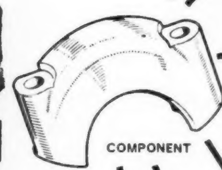




Station 1
LOAD

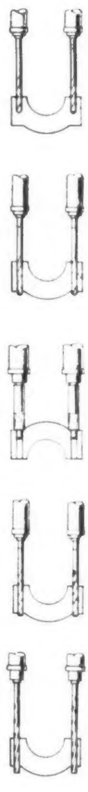
Station 2
DRILL
2 holes
½ depth

Station 3
DRILL
2 holes
break
through

Station 4
SPOT FACE
bearing
faces

Station 5
CORE DRILL
open 2
bolt holes

Station 6
REAM
2 bolt holes



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ROTARY TRANSFER MACHINES

for higher production

★ This compact space and time saving machine employs four BROOKE UNIT HEADS. Model UH.O and one Model UH.1. Note the complete accessibility of the Heads and Tooling.

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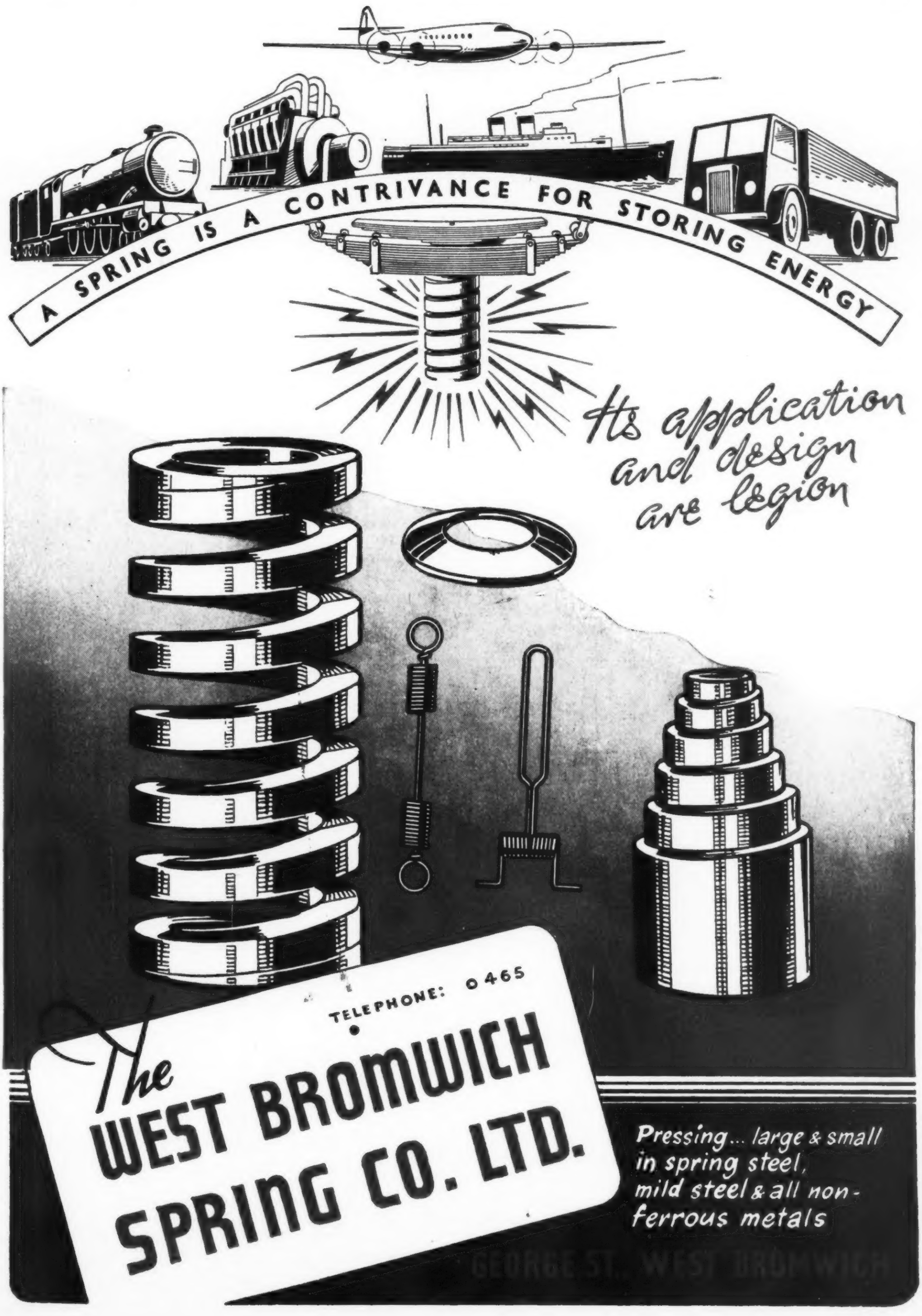
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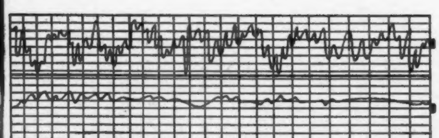
PRESTO

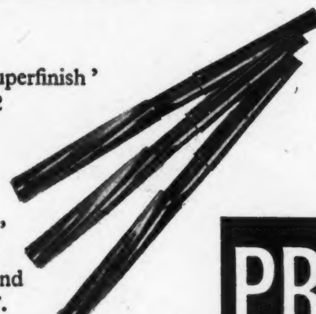
reamers

cost no more
ream smoother holes
and last longer



Surface finish reading from bore with a standard finish Reamer.

Note improved surface finish obtained from PRESTO 'Superfinish' Reamer.



The cutting lands of PRESTO 'Superfinish' Reamers have a surface finish to 2 micro inches— thus ensuring improved finish in the holes produced and increased tool life through resistance to metal pick-up.' PRESTO 'Superfinish' Reamers are supplied at no extra charge and are available in hand and machine types in sizes 5/16″ to 1″.

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CHUCKING
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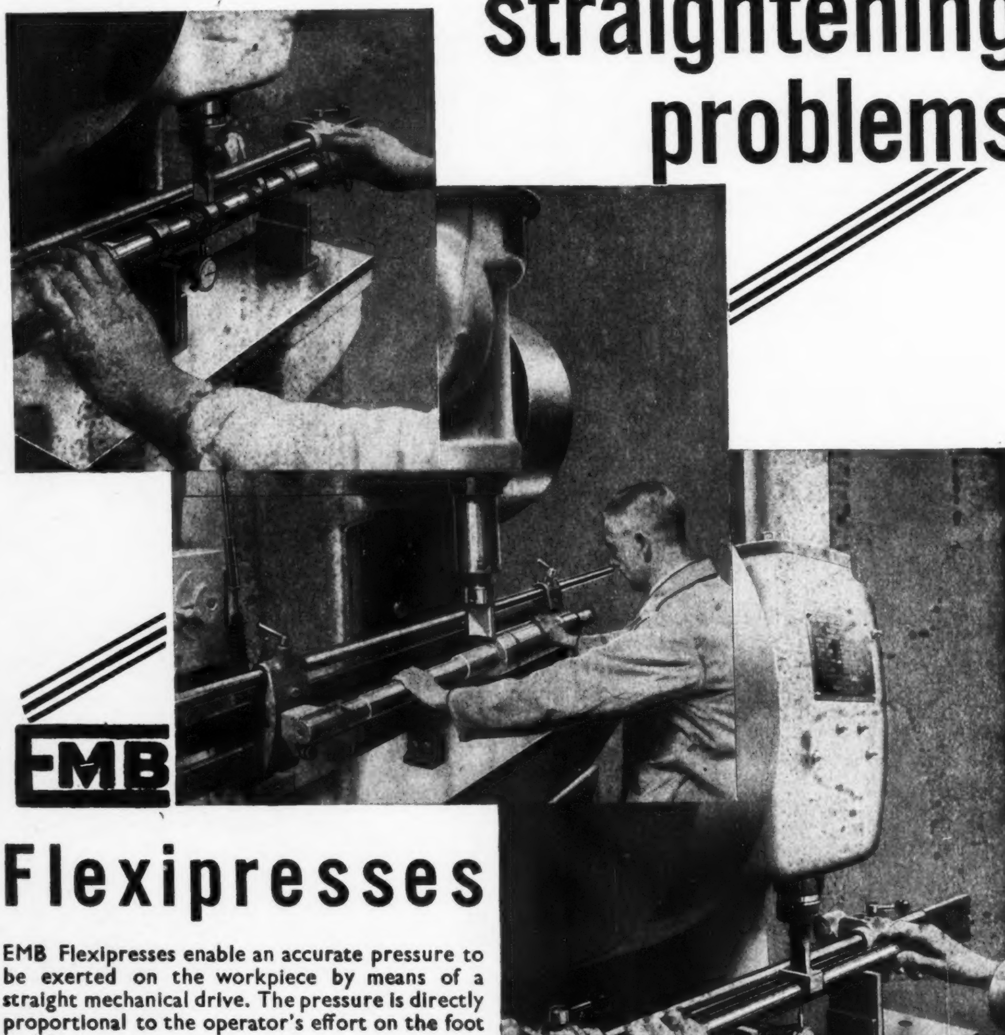

Flexipresses

EMB Flexipresses enable an accurate pressure to be exerted on the workpiece by means of a straight mechanical drive. The pressure is directly proportional to the operator's effort on the foot pedal.

In combination with EMB straightening device, these machines are therefore ideal for straightening heat treated shafts.

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AUTOMATIC HYDRAULIC DUPLICATING DIE-MILLER combined with a TOOL-ROOM MILLING MACHINE

SPECIFICATION

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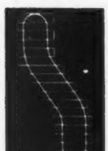
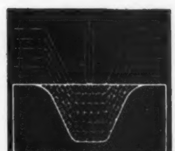
Longitudinal table trav. (hydr.+manual)	14in. + 14in.
Vertical (knee) hydr.+manual	4in. + 13in.
Vertical (quill) (mechanical)	5in.
Cross (saddle) (hydr.+manual)	10in. + 10in.
Spindle speeds range r.p.m.	80 to 2715

PRICE £2,125 - 0 - 0 ★

3 Hydra-Way Duplicating ***(Finishing)***



1 Automatic Horizontal Scanning of the Model "by Lines"



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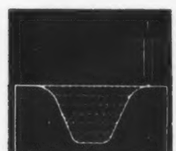

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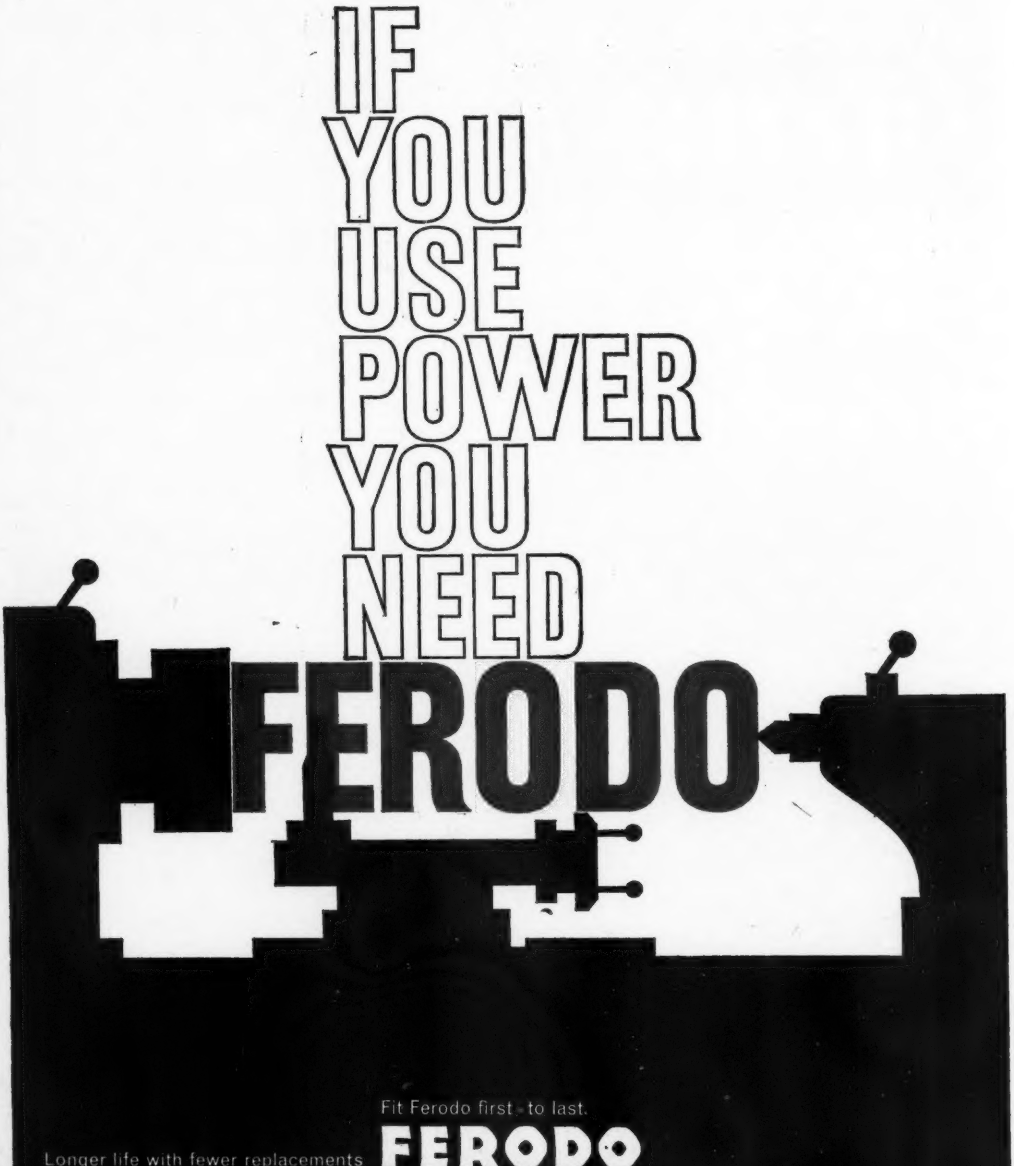
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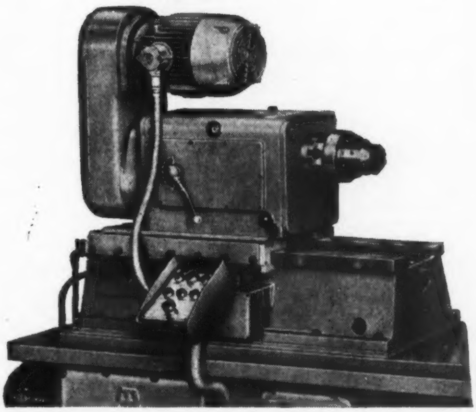

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CONTENTS

Abstracts of Principal Articles

Producing the Smiths Automatic Transmission .. .. P. 832

At the Witney, Oxon., factory of S. Smith & Sons (England), Ltd., spring drive units are assembled to inner rotors, for automatic transmissions for motor cars, on a specially-equipped power riveting machine. Each assembly is statically balanced to determine which of a range of pressings shall be fitted to form a labyrinth seal, the pressings being retained by spinning over a flange on the inner rotor on a Turner machine. Inner rotor sub-assemblies are assembled to outer rotors by means of a Hi-Ton hydraulic press, which has two operating pressures, one for assembling a bearing, and the other, for assembling the inner rotor to the outer rotor. Complete rotor assemblies are checked for concentricity and then dynamically balanced on a Jackson & Bradwell machine, fitted with Par-A-Matic air-operated units for drilling correction holes. Final assembly of stators and rotor units to gearbox assemblies, supplied by the Rootes Group, is carried out on a fixture with an indexing unit provided with sliding supports for a stator and a rotor, also equipment for performing a concentricity check. (MACHINERY, 99—11/10/61.)

The Manufacture of Precision Instruments P. 842

The second of a series, this article makes reference to the South Works of VEB Carl Zeiss, Jena, and to some of the heavier machine tools employed in the main machine shop. Typical set-ups are described, on standard and special machines, including a planomiller originally built by Zeiss for operations on range-finder housings. Attention is also drawn to a special machine for automatically lapping part-cylindrical ways in large castings for universal measuring machines. Mention is then made of the die casting foundry, which works continuously on a 3-shift basis, and is equipped with Czechoslovakian Polak machines. Finally, a Zeiss-designed turret-type instrument lathe, fitted with special thread chasing equipment, is described. (MACHINERY, 99—11/10/61.)

Rubery Owen-Swift Cupping Test Press P. 851

A compact machine for use in deep drawing research and primarily for performing Swift cupping tests under controlled conditions has been developed by the Research and Development Department of Rubery Owen & Co., Ltd., Darlaston, Staffs. The machine is similar to an inverted hydraulic press, and the ram applies force to the punch in an upward direction, the specimen being held in a blankholder mounted beneath a die. The ram may be powered by a hydro-pneumatic accumulator or from a motor-driven pump, of 2-gal. per min. output. A maximum force of 37 tons can be exerted, and the blankholder force can be varied from 0 to 8 tons. (MACHINERY, 99—11/10/61.)

Evaluation of the Effects of Spline Misalignment .. .. P. 853

Splines of the clearance-fit or sliding type may fail in a number of ways, including shear of the splines, compression of the splines, breakage at the roots of the splines due to bending, wear due to fretting corrosion, and bursting of the female splined member on account of radial, tangential and centrifugal stresses. The probability of such failure is greatly increased by any misalignment of the splines. An understanding of the quantitative effects of misalignment is therefore important, in order that due allowance for such effects can be made in the design of the splines. In this article (the first of two) the determination of clearances and interferences of misaligned splines is discussed, and the elimination of interference between splines is considered, also the relation of the length of engagement to clearances. Reference is also made to the effect of misalignment on load capacity. (MACHINERY, 99—11/10/61.)

Eastern Bloc Machine Tools .. P. 861

It is evident from increased advertising and participation in British and Continental exhibitions, that Eastern Bloc machine tool building organizations are making considerable efforts to penetrate Western markets. The majority of machine tool engineers are aware of the quality of the products of these organizations, but may not be conversant with the price levels at which these products are likely to be offered, or the extent to which markets may be penetrated due to price differentials. In this article, a comparison is made between the price per ton of machine tools exported from the U.S.S.R., Czechoslovakia, Hungary, Poland and East Germany to the U.K., West Germany, France, Switzerland, Italy and Austria. (MACHINERY, 99—11/10/61.)

Contributions to MACHINERY

If you know of a more efficient way of designing a tool, gauge, fixture, or mechanism, machining or forming a metal component, heat treating, plating or enamelling, handling parts or material, building up an assembly, utilizing supplies, or laying out or organizing a department or a factory, send it to the Editor. Short comments upon published articles and letters on subjects concerning the metal-working industries are particularly welcome. Payment will be made for exclusive contributions.

EDITORIAL

The Extending Field for Vapour Blasting and Allied Processes

The process known as vapour blasting, whereby a mixture of water and fine abrasive is projected against work surfaces to produce a variety of effects, has now been established for a number of years, and its value for numerous purposes is widely appreciated. It appears, however, that the extent to which the basic process has been modified and adapted to meet a diversity of requirements, with consequent rapid expansion in the field of application, is not sufficiently recognized.

When compressed air is supplied to the gun for the purpose of imparting the required velocity to the abrasive-water mixture, or increasing the velocity obtainable by pump pressure, vapour blasting exerts a mild abrasive action. The process then serves to improve the surface finishes on workpieces of many types, and to remove burrs resulting from machining operations, and it is applied very extensively to obtain such effects. In addition, it has been adopted for more specialized purposes, for example to facilitate examination of the condition of cemented carbide tool tips, as a means of ensuring improved performance. It has been found that when tools are treated in this manner, cracks in the carbide material, which may be present originally, or may be formed as a result of re-grinding, can readily be detected. The searching action of the vapour blast also serves to reveal other defects, such as undue porosity which may adversely affect tool life, and incorrect brazing. At the same time, it is stated, the treatment serves to eliminate any burr resulting from the grinding operation and to leave a cutting edge equivalent to that obtainable by honing.

It is believed that if compressed air is employed in the blasting process it has the effect of separating the abrasive particles from the water in the jet, with the result that they have a more intensive cutting action on striking the work. On the other hand, if the jet velocity depends solely on pump pressure, each particle is surrounded by a film of water which tends to reduce its effectiveness and a polishing rather than a cutting action is obtained. To enable advantage to be taken of these different characteristics, equipment now available can be operated with air acceleration of the jet to obtain comparatively rapid metal removal during the initial stages of treatment, and then with pump pressure only, for final polishing to a high degree of surface smoothness.

As is well known, one important application of vapour blasting is for the treatment of certain types of moulds and dies to provide smooth matt surfaces before the tools are put into service. For this purpose, metal removal is obviously necessary, but vapour blasting is also employed extensively for removing the deposits which build up on mould surfaces in service, and a highly selective action is then desirable. Unless particular care is taken, cleaning operations carried out by the normal process result in some erosion of the metal surfaces and rounding of edges, with the result that the effective life of a tool may be considerably reduced. To solve this problem in connection with the cleaning of large tyre moulds, for example, spherical particles of toughened glass have been introduced, which are employed as the vapour blasting medium instead of the normal fine abrasives. These glass particles, it is claimed, effectively remove the contaminants but have no measureable action on the metal surfaces. With this medium, again, treatment can be carried out with air acceleration of the jet for rapid cleaning, and under pump pressure alone for final polishing. Apart from their use for mould cleaning, the glass particles have other applications where a very light peening rather than an abrasive action is required.

Following the development of a method of applying the blasting medium by means of a centrifugal impeller, which delivers a stream of long but fairly narrow cross-section, it has been possible to treat much larger surface areas than could hitherto be processed economically. For example, equipment has been supplied for the continuous treatment of steel strip up to 54 in. wide which is traversed through the overlapping streams delivered by two impellers. The full width of the strip is covered at one pass, and it is stated that traversing speeds up to 25 ft. per min. can be employed, depending on the initial condition of the strip and the nature of the finish required. As a further indication of the potentialities of the centrifugal impeller, it may be noted that a prototype plant has been successfully employed for the "flatting" treatment of assembled motor car bodies

(*Continued on page* 881)

Producing the Smiths Automatic Transmission

Methods and Equipment Employed for Building Sub-assemblies for this Ingenious Electro-mechanical Unit at the Witney Factory of S. Smith & Sons (England), Ltd.

By P. A. SIDDERS, Chief Associate Editor

MACHINING OF COMPONENTS for the automatic transmission units developed by S. Smith & Sons (England), Ltd., for use in the Easidrive versions of Hillman Minx and Singer Gazelle cars, was described in earlier articles in this series.* Reference was made to the battery of Muller Eltropilot lathes, which, with Drummond Maximinor, Vertimax No. 3 and New Britain 2-spindle machines, are installed in the machine shop at the company's Witney, Oxon., factory, for turning operations on the major components. Inspection procedures and equipment have been discussed, and the company's use of hard chromium plating of surfaces subject to wear, to eliminate heat treatment and thus maintain magnetic properties was considered. Some of the more interesting set-ups for building sub-assemblies for the transmission unit form the subject of this article, in which attention is also drawn to the final assembly arrangements.

* MACHINERY, 99/60—12/7/61, 99/404—23/8/61 and 99/708—27/9/61.

Each inner rotor assembly—front or rear—comprises principally an inner rotor (the machining operations on which have been described), a Borg & Beck spring drive unit, a cover plate, and two annular pressings which form a labyrinth-type seal to trap the chromium iron powder whereby the drive is transmitted. Assembly is performed in two stages at a group of machines comprising a riveting unit supplied by the Bifurcated & Tubular Rivet Co., Ltd., a Turner spinning press, and a Jackson & Bradwell balancing machine, with associated bench stations.

A front inner rotor sub-assembly is seen on the left at the rear in Fig. 1, which also shows the parts that are assembled at the first stage. At a bench station on the right-hand side of the riveting machine, the mating faces of the spring drive unit *A*, the inner rotor *B* and the cover plate *C* are coated with Goodyear Pliobond 20 sealing compound, by means of a brush, preparatory to assembly and the fitting of the rivets seen at the right.

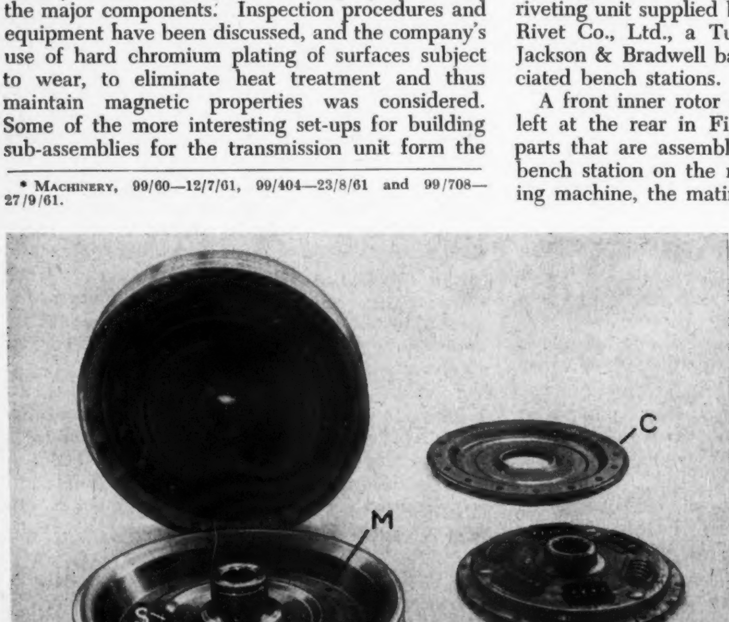


Fig. 1. An inner rotor assembly for the automatic transmission is seen at the rear on the left, with an inner rotor, cover plate, spring drive unit and rivets

Fig. 2 shows the riveting machine, which is equipped with a hand-operated indexing fixture *D*. Indexing of the upper platen of the fixture is effected by means of the lever *E*, which is connected to a pawl and ratchet mechanism. Mechanical interlocking is incorporated to prevent operation of the machine while the platen is being indexed. A block *F* is secured to the cranked rod that connects the operating

pedal of the machine to the clutch whereby drive is transmitted to the crankshaft. When the clutch is disengaged, and the pedal is in the raised position, the block is above a spring-loaded plunger that slides in the housing *G*. This plunger is thrust outwards when the lever *E* is moved to index the table, and obstructs the downward movement of the block and rod, thus preventing operation of the clutch. The plunger cannot return to its original setting until the indexing movement has been completed, and a location pin coupled to the lever *E* has been engaged with one of the holes in the periphery of the platen. Over-run of the platen during indexing is eliminated by a pad brake, which is mounted in the bracket *H*, and is urged by a spring into engagement with the platen periphery.

On the platen there are 16 dolly assemblies, and each has a sliding, spring-loaded plunger to support the rivets. A hole in the centre of the platen provides for location of the spigot of the inner rotor, and through this hole projects a rod *J*, with a tapped hole in the upper end. This rod slides in the fixture body and its lower end is coupled to the piston rod of an air cylinder *K*, which is mounted, on pillars, as shown. The cylinder is supplied with compressed air by way of the Enots AC211 dead-man valve *L*. When the valve lever is in the free setting, as shown, air is directed to the upper end of the cylinder to pull the rod *J* downwards.

An inner rotor is loaded on to the platen, with the spigot downwards, so that the plungers of the riveting dollies project through the holes *M*, Fig. 1. The spring drive unit *A* and cover plate *C* are then assembled, and the lever of the valve *L*, Fig. 2, is moved towards the rear of the machine to raise the rod *J*. A clamping pad, which is now assembled over the rod, has splines that engage those in the bore of the spring drive unit. By turning the pad, by means of its knurled flange, the spring drive unit can be turned to align it with the holes in the inner rotor. A captive screw in the pad is next engaged with the tapped hole in the rod *J*, and run home, before the valve *L* is released to direct air to the cylinder to pull the rod downwards and clamp the components of the assembly on the platen.

Rivets (of domed head semi-tubular type, with shanks of $\frac{5}{32}$ in. diameter by $\frac{3}{8}$ in. long) are fed to the riveting head *N* from a magazine. Each time that the operating pedal of the machine is depressed, the head is moved down to insert a rivet through the assembly and expand the lower end. The platen is indexed to bring the holes in the components successively beneath the head, and the pedal is depressed in phase with the indexing movements.

Fig. 2. This Bifurcated & Tubular Rivet Co. machine has been equipped for the assembly of inner rotors at the Smiths Witney factory. Mechanical interlocking prevents operation of the machine unless the table has been fully indexed

STATIC BALANCING

After the assembly and riveting stage, inner rotor sub-assemblies are statically balanced to determine whether plain or counterweighted labyrinth elements should be fitted. A front inner rotor sub-assembly, with the labyrinth in position, is seen at the rear in Fig. 3, and the two elements that comprise the labyrinth are also shown. Both elements are of conical form, and the outer element, indicated at *P*, has a wide flange, with a step to receive the narrow flange of the inner element *R*. Both elements fit over the annular rib *S*, Fig. 1, which is of triangular cross-section, and this rib is subsequently spun over to secure them in position.

The outer element *P*, in the foreground of Fig. 3, has two counterweights *T*, and elements of this type are also available with one counterweight. On the basis of the static balancing check, a suitable outer element is selected for assembly to obtain the amount of correction necessary.

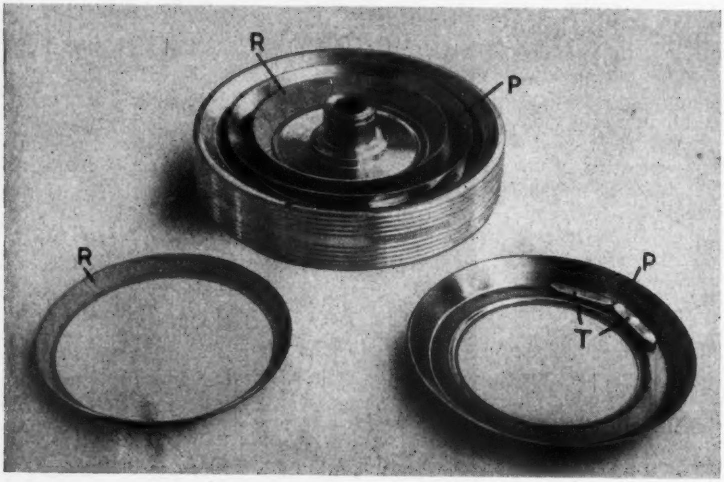


Fig. 3. An inner rotor sub-assembly with two pressings that are fitted to form a labyrinth seal. Pressings, as seen at the right, are available without counterweights, or with one or two weights to correct the balance of the assembly

SPINNING OPERATION

Fig. 4 is a close-up view of the Turner spinning press, which is provided with a fixture *U*, that can be traversed on cylindrical guideways *V*, by means of an air cylinder *W*. The guideways are fitted to a base, of steel fabricated construction, which is bolted to the table of the machine, and the fixture can be moved from the operating station beneath the spinning tool *X*, to a position clear of the machine (as seen in the illustration) for loading and unloading. Movement of the fixture is controlled by an Enots valve *Y*, to which air is delivered from the shop supply line by way of a reducing valve and pressure gauge assembly. A second reducing valve and gauge unit, mounted on the column of the machine, regulates the pressure of the air delivered to the cylinder for traversing the vertical ram that houses the spindle carrying the spinning tool.

A riveted sub-assembly (comprising an inner rotor, spring drive unit and cover plate) is first loaded on to the fixture, as seen at Z. An outer labyrinth element is then placed in position, followed by an inner element, and the fixture is moved to the spinning position. The downward traverse of the machine ram is next engaged, and the spindle is driven at 45 r.p.m. There are three angularly-disposed rollers in the spinning tool. These rollers are made from steel, and hardened and ground, and each is applied to the annular rib of the inner rotor.

After the spinning stage, the inner rotor sub-assemblies are degreased, and are then ready for assembly to the outer rotors. It may be mentioned here that the Turner spinning machine is

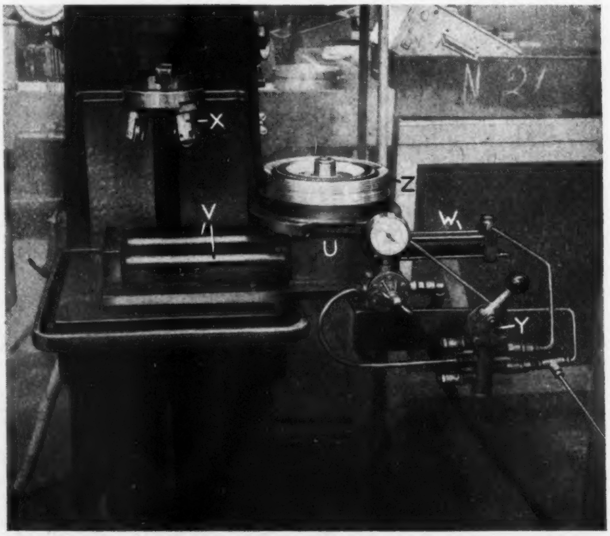


Fig. 4. An inner rotor sub-assembly is here seen on the Turner machine that provides for spinning over a rib to retain the labyrinth pressings. To facilitate loading, the fixture can be traversed to one side by means of an air cylinder

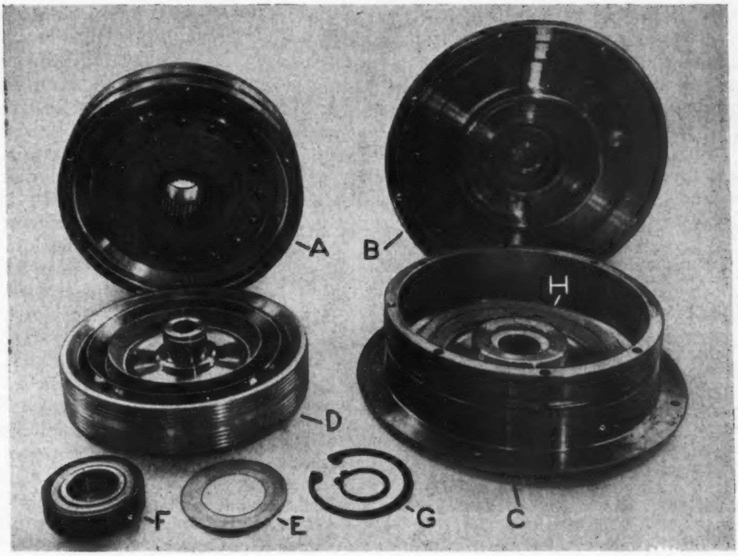


Fig. 5. Front and rear rotor assemblies are here shown, also the components which form the front rotor assembly

also used for the assembly of labyrinth elements to outer rotors.

ASSEMBLY OF COMPLETE ROTOR UNITS

A group of components for a complete front rotor assembly is seen in the foreground in Fig. 5, and at the rear, an assembled rear rotor *A* and front rotor *B*. At *C* is indicated a front outer rotor, and at *D*, an inner rotor unit, the assembly of which has just been described. The operations performed at this assembly stage comprise mounting the oil slinger *E* and ball bearing *F* in the outer rotor, then assembling the inner rotor so that its spigot passes through the bearing inner race, and, lastly, fitting two circlips *G* to retain the components. It may be observed that labyrinth elements *H* have already been fitted to the outer rotor prior to this assembly stage.

Assembly is carried out on a Hi-Ton hydraulic press, and a close-up view of the working zone is given in Fig. 6. This area is enclosed by a swing-guard *J* during the working cycle, which is initiated by closing the guard. A ball bearing and an oil slinger are first loaded into the lower tool *K*, and an outer rotor, as at *L*, is then mounted on top of these components and thrust downwards, with the result that the bearing and oil slinger are assembled in the smaller bore. The guard is now raised, the press ram being then automatically withdrawn, and an inner rotor sub-assembly *M* is loaded into the outer rotor, when the guard is again lowered, the inner rotor is

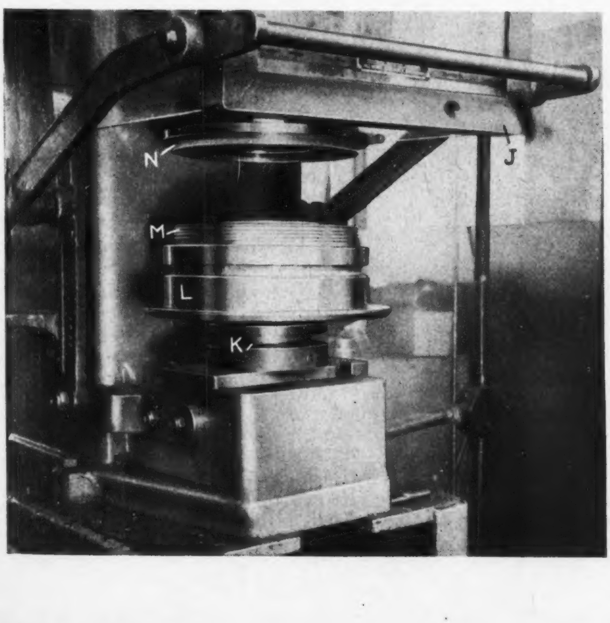


Fig. 6. Assembly of outer rotors to bearings, and inner rotors to outer rotors, is performed on this Hi-Ton hydraulic press, which provides a high pressure for the first stage, and a low pressure for the second, to avoid dishing of the inner rotor

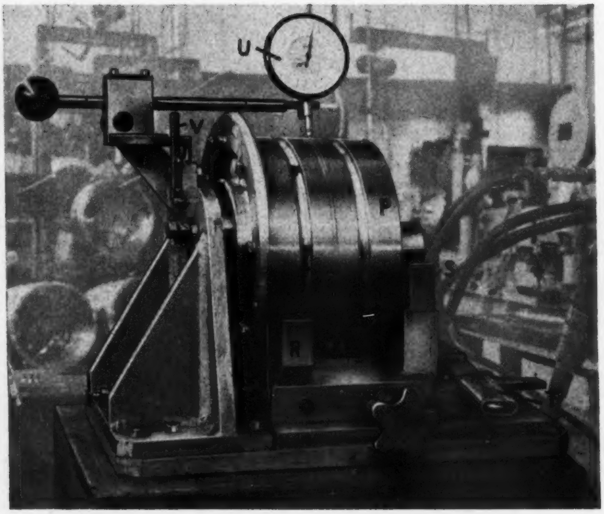


Fig. 7. This equipment is employed at the Smiths Witney plant for checking the concentricity of rotor units after assembly. The work supports are arranged to slide to facilitate loading

thrust downwards so that its spigot engages the bore of the inner race of the bearing. A stepped top tool is fitted to the press ram, as seen at *N*, and serves to apply thrust to both the outer and inner rotor. The hydraulic system of the press is arranged to deliver oil to the ram at two pressures, namely, 1,000 lb. per sq. in. for assembling the outer rotor to the bearing, and at 500 lb. per sq. in. for assembling the inner rotor, this reduced pressure being used to avoid the possibility of dishing the latter unit.

Rotor assemblies from the Hi-Ton press are placed in Rack Engineering trolleys, similar to those described in an earlier article. In this instance, however, the peg-type supports are not employed, the trolleys being fitted with work holders in the form of steel shelves. Each holder is divided to form a series of bins, and an assembly is carried in each bin. The assemblies are delivered on the trolleys to a bench station, where front and rear rotors and dividing plates are bolted together. This work is performed with the aid of a fixture mounted on the bench, and the components are secured with toggle clamps after the bolt holes in the three members have been aligned. Between the bolt heads and the front outer rotor are fitted sector plates which serve as multiple tab washers, and the bolts are screwed into tapped holes in the rear outer rotors with the aid of twin-spindle Desoutter runners, suspended above the bench. At this stage, the rear bearing hub is also fitted to the rear outer rotor and secured with screws. As each front rotor assembly is removed from the trolley rack, it is stamped with a serial number.

After assembly, each complete rotor unit is subjected to checks for concentricity and balance, and the equipment for the concentricity check is seen in Fig. 7. The rotor unit *P* is placed intially on V-type supports *R* and *S*, which receive the front outer rotor and rear bearing hub respectively. These supports are fitted to a slide, which can be moved to the right, by means of the hand-lever *T*, to facilitate loading. An angle bracket at the left-hand end of the checking fixture carries two ball-bearings, and stop nuts on a screw control the positions of the slide carrying the work supports at either end of its travel. When the slide is moved as far as possible to the left, from the loading position, the two ball-bearings engage the flywheel register of the front outer rotor, with the result that the rotor assembly is lifted from the V-support *R*. The assembly is then supported by the rear bearing (which rests in the V-support S) and the flywheel register, the mounting arrangements when the transmission unit is installed in a car being thus simulated.

At the top of the angle bracket, to the rear, is welded an arm whereon is pivoted a block carrying the dial indicator gauge *U* for the concentricity check. The arm is a sliding fit in the block, and can be set in four positions, controlled by V-grooves in the arm and a spring-loaded plunger in the block. For loading, the block can be swung about its pivot, to bring the gauge clear of the work supports, and for checking, the block is secured by a spring loaded pawl *V*, with the gauge-carrying rod horizontal. The dial gauge is calibrated in 0·0001-in. units, and the concentricity of the assembly in four positions must be correct within a total indicator reading of 0·003 in.

DYNAMIC BALANCING SET-UP

From the concentricity checking station, the complete rotor units are transferred to a specially-adapted Jackson & Bradwell dynamic balancing machine, which is shown in Fig. 8. Eight studs are first assembled to the flange of the front outer rotor, with the aid of a Desoutter air-operated

driver. A spider is then fitted to four of the studs, and serves to transmit the drive from the spindle of the balancing machine to the rotor unit. Next, a dummy shaft is assembled through the splined bores of the front and rear inner rotors, and the rotor unit is loaded on to the two supports of the machine, where it is carried on freely rotating discs, with which the spider unit and the rear bearing hub make contact. The spider is connected to the machine spindle by a universal coupling, and the inner rotors are prevented from rotating by inserting a bung in the end of the dummy shaft, this bung being anchored to the machine base by means of a length of standard rubber hose.

The Jackson & Bradwell machine is semi-automatic in operation, and incorporates an electro-magnetic brake system. There are four meters on a control panel at the front of the headstock, two of which indicate the amounts of unbalance, in the planes of the flange and end wall of the rotor unit, and two, the corresponding angular positions. Two Par-A-Matic air operated drill units, as at *X*, are mounted on a bracket that can be traversed along the machine bed by means of the capstan handle *Y*. At the start of a balancing cycle, the drive and brake systems are switched on, and after a pre-set period has elapsed, the machine spindle is stopped, and the rotor unit is turned by hand to the position for drilling the correction holes.

A steady unit Z, pivotally mounted on the front of the headstock, is then swung down, as shown. In this position, two bars, which extend from the yoke member of the unit, engage the flange of the front outer rotor and support the complete rotor unit against the drilling thrust. One drill unit is employed to machine a correction hole in the end of the rear outer rotor (nearer to the camera in the illustration), and the other is fitted with an extension piece, to provide for drilling a correction hole in the flange of the front outer rotor. The depth of hole drilled is controlled by a stop-stud that projects from a box mounted above each drilling unit. Drills are of a constant diameter and are carefully ground to ensure that the points are of consistent shape. If one correction hole does not suffice, additional holes are drilled, symmetrically disposed about the first, in accordance with indications on the meter for the amount of unbalance. The controlled depth and diameter of the holes ensures that balancing is carried out to a tolerance of 0·3 oz.-in.

For drilling, the support bracket carrying the Par-A-Matic units is moved along the machine bed by means of the capstan handle *Y*, to a predetermined position that is controlled by a stop. Drive to the drilling spindles is then engaged by pressing push-buttons on the control box mounted on the machine headstock. The drills are fed automatically to the pre-set depth, and are then automatically withdrawn, the support bracket being returned to its original position, by hand, when the drills have been fully retracted. After the drilling operation, the balance of the complete rotor unit is re-checked, and a further correction is made if necessary.

Following the balancing operation, each complete rotor unit is passed to a bench where 72 gm.

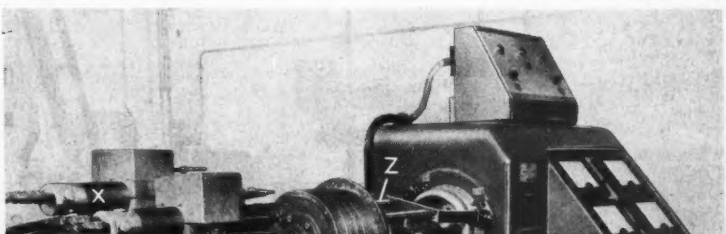


Fig. 8. Rotor units are dynamically balanced on the specially-equipped Jackson & Bradwell machine here shown. After the balance has been checked, the necessary correction holes are drilled in the end face and the flange by means of the Par-A-Matic air-operated units

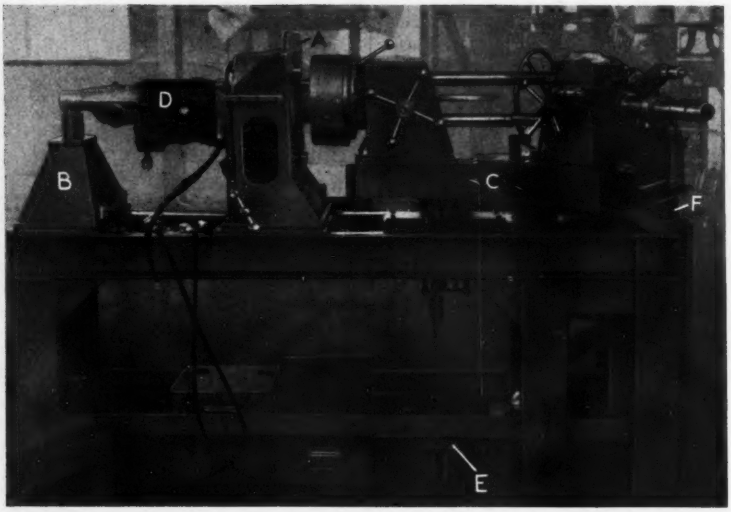


Fig. 9. This fixture is employed for assembling stator and rotor units to gearbox units supplied by the Rootes Group. An indexing support at the right carries a stator, a rotor and concentricity checking equipment

of chromium iron powder is introduced into the front and rear sub-assemblies through holes in the outer rotors. These holes are threaded, and are closed with screwed plugs.

Stator assemblies for the transmission units are built in an adjoining section, and both types of unit are passed to a spray booth, where Molytox compound is applied to the inner surfaces of the stator unit and the outer surfaces of the rotor unit. The units are then loaded on to a conveyor that delivers them to the final assembly station, the delivery time allowing for air-drying of the sprayed coating.

FINAL ASSEMBLY ARRANGEMENTS

In addition to the stator and rotor units, gearboxes for use with the automatic transmission units are delivered to the final assembly station. These gearboxes—for the Easidrive versions of Hillman Minx and Singer Gazelle cars—are built by the Rootes Group, and are despatched to the Witney factory in groups of three mounted on pallets. On arrival at the final assembly station, the gearboxes are unloaded from the pallets, and from each is removed a grit shield, that closes the end of the bell-housing during transport, and a guard that protects the solenoid mounting.

With these preliminary operations completed, the gearbox is loaded into the assembly fixture seen in Fig. 9. This fixture has a base, constructed by welding from steel sections and plate, whereon is mounted an angle plate *A* to receive the bell-housing of the gearbox assembly, and a sub-base *B*, which carries a V-block to support the tail-housing of the assembly. At the end of the base remote from the sub-base *B* is pivoted a unit *C*, which is Y-shaped in plan. This unit can be swung about a vertical axis, and each arm of the Y-form can be located in line with the gearbox — indicated at *D*. For indexing, a spring-loaded bolt engages the bore of a bush in the lower side of each arm, and the bolt can be withdrawn by depressing the pedal *E*. The base is extended to the rear, at the end which carries the unit *C*, and this extension is at an angle of 120 deg. to the main portion, so that one arm of the unit *C* is positioned above it, when another is aligned with the gearbox. The extension is indicated at *F* and it is provided with cylindrical guide-members for a sliding support, to which reference will be made later.

For loading the gearbox there is an overhead hoist which is fitted with a special grab, of a type to be described in the final article of this series. Fig. 10 is a close-up view of the angle plate and sub-base of the fixture with a gearbox assembly in position. Initially, the assembly is supported by the V-block *G*, also by two pegs, as at *H*, which extend from the angle plate and are engaged by the flange of the bell housing. The assembly is then slid towards the angle plate until the flange face of the bell housing abuts a facing, and holes in the flange—which subsequently serve for dowelling the complete transmission and gearbox assembly to the engine—are engaged with two dowel pins.

With the gearbox thus located, the handle *J* is turned to swing two clamps into engagement with the flange of the bell housing. One clamp is indicated at *K*, and each is mounted on a vertical shaft that is free to pivot on the base of the angle plate *A*, also in a bearing carried on an arm attached to

the side member of the plate. Near the lower end of each shaft is fitted a lever, as at *L*, and the end of the lever remote from the shaft is pivoted on a block, seen at *M*. Each block has a threaded hole and an open-end slot, and the hole is engaged with a screwed portion at the end of the spindle which carries the handle *J*. The slot embraces a plain rod that extends from one side member of the angle plate to the other and is parallel to the spindle, so that the blocks are retained in a horizontal plane. The screwed portions at each end of the spindle have threads of opposite hand, and the blocks are tapped to suit, the arrangement being such that by turning the handle *J* in one direction, both clamps are swung inwards to contact the bell-housing flange. When the handle is turned in the opposite direction, the clamps are swung clear. The spindle can float axially, compensation being thus provided for variations in the thickness of the flange.

Fig. 11. Arrangements for supporting a stator sub-assembly on the indexing unit of the final assembly fixture. The stator is held by a radially-moving pad on the cylindrical support, which serves to align the stator with the gearbox

ASSEMBLY OF STATOR

The unit *C*, Fig. 9, has three arms, as already explained, and on one arm is mounted equipment for assembling stators to the bell-housings of gearbox units. Fig. 11 is a close-up view of this equipment, with a stator in position, as indicated at *N*. A fabricated steel bracket *P* is bolted to the arm of the unit *C*, and it incorporates bushes wherein slide two cylindrical bars that carry the work support *R*. A rack is secured to the support and extends parallel to—and between—the two bars. This rack is engaged by a pinion mounted on a shaft to which the capstan handle *S* is fitted. The arrangement is such that the work support *R* can be moved away from and towards the bracket *P* by turning the capstan handle.

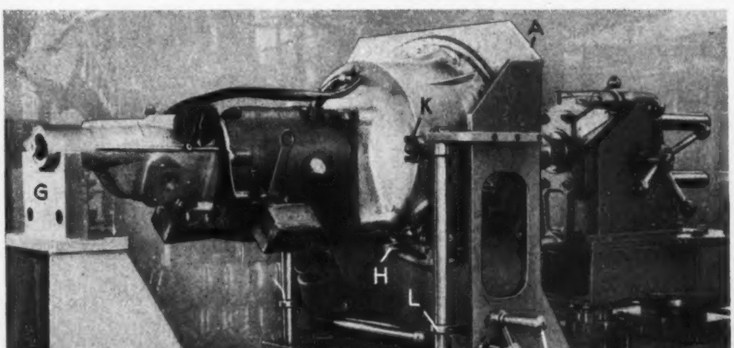


Fig. 10. Close-up view of the angle-plate mounting for the gearbox unit on the final assembly fixture. Swinging clamps are moved to engage the flange of the bell-housing by turning the crank-handle at the front of the fixture

There are six bronze pads in the work support *R*, with which the internal surface of the stator unit makes contact, and one of these pads, indicated at *T*, is arranged to slide radially in its slot. The pad *T* can be thrust outwards,

to secure the stator unit on the support, by turning a cam *U* that is free to rotate on the central spigot of the support. To enable the stator unit to be aligned with the gearbox assembly, the complete work support *R* can be turned on a shaft that passes through the central spigot, and locked by a lever-operated face cam at the rear.

With a stator loaded on the work support, the Y-shaped unit *C* is indexed to align it with the gearbox assembly already mounted on the angle plate of the assembly fixture. The work support is then moved forward to advance the stator into the bell-housing of the gearbox, and the support and stator are turned to align the eight fixing holes in the stator with mating holes in the bell-housing. Eight bolts are then fitted and screwed home to uniform tightness, to secure the stator, and the work support is withdrawn.

CONCENTRICITY CHECK

After the stator has been assembled and the work support has been moved clear of the angle plate, the Y-shaped unit *C* is indexed through 120 deg. in a clockwise direction (as viewed from above) to bring concentricity checking equipment into line with the stator. This equipment is seen in Fig. 12, and it is mounted on cylindrical bars, and can be traversed axially by a capstan-operated pinion and rack, the arrangement being similar to that provided for the work support employed for assembly of the stator. On the end of the bars is mounted a 3-armed spider *V*, with a centrally-disposed tubular mandrel, which is accurately ground. The upper arms of the spider are fitted with spigots, as at *W*, and the third arm with a stop member *X*. When the equipment is advanced, the central mandrel passes over the gearbox input shaft and enters the bore of the inner race of a ball bearing in the bell housing. This bearing, which receives the rear bearing hub of the inner rotor, is co-axial with the stator. The spigots on the spider engage location bushes on the angle plate *C* of the assembly fixture, and the checking equipment is then moved towards the gearbox until the stop member *X* contacts a hardened steel pad on the face of the angle plate.

The central mandrel of the spider carries a sleeve *Y* which is a good sliding fit. Extending radially from the inner end of the sleeve is a mounting for a dial indicator gauge *Z*. The plunger of this gauge contacts the internal surface of the stator, and the sleeve and gauge are turned on the mandrel for checking the concentricity of the stator interior with the gearbox. Checking is carried out at three positions—inner, central and outer—along the length of the stator, and maximum permissible total indicator readings at these positions are 0·006, 0·005 and 0·005 in. respectively.

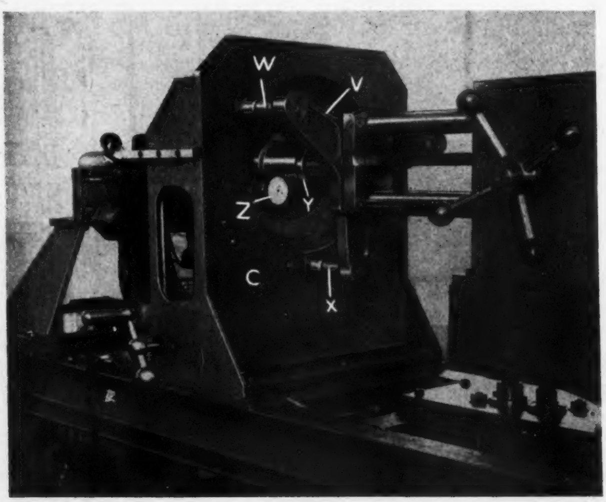


Fig. 12. This equipment is provided on the final assembly fixture for checking the concentricity of the stator after it has been mounted in the bell-housing of the gearbox unit. Checks are carried out at three different positions along the length of the main bore of the stator

ASSEMBLY OF ROTOR UNITS

After a stator unit has been loaded and before it is bolted to the gearbox assembly, a rotor unit is mounted on a support on the third arm of the indexing unit *C*. The arrangements for loading and supporting the rotor are shown in Fig. 13. Again, the arm of the unit *C* carries a fabricated steel bracket *A′* with sliding bars fitted with a work-support *B′*. This support can be moved towards and away from the bracket by a rack and pinion arrangement, similar to those already mentioned. In this instance, however, a large operating hand-wheel *D′* is provided in place of a capstan handle, to afford greater purchase.

For loading, the unit *C* is located so that the work-support *B′* is aligned with the extension at the rear of the base of the assembly fixture, to

which reference has already been made. In Fig. 13, this extension is again indicated at *F*, and the cylindrical guide-members, previously mentioned, can be seen at *E′*. A slide *G′*, of box construction and fabricated by welding from steel plate, is free to move on the guide-members. On this slide is mounted a cradle *H′*, with bronze pads, on which a rotor assembly *J′* is loaded with the aid of an overhead hoist.

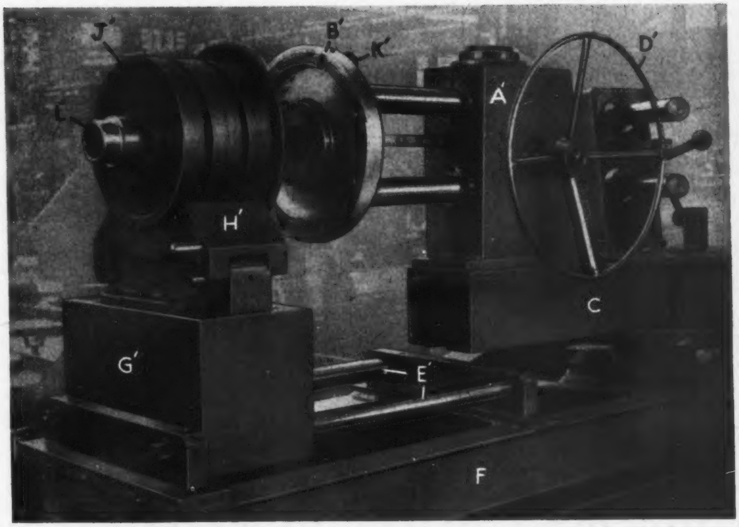


Fig. 13. A rotor sub-assembly is here seen on the preliminary support which forms part of final assembly fixture. The support is moved to engage the rotor with the carrier whereby it is brought into alignment with, and inserted in, the previously-assembled stator

With the work-support *B′* fully advanced, as shown, the slide *G′* is moved on the associated guide-members to engage the location spigot on the front end of the rotor unit with the mating register diameter on the support, and the rotor unit is aligned so that the studs fitted to the flange pass through holes in the support. Captive nuts are provided on the support, at diametrically opposite positions, and one nut is just visible at *K′*. These nuts are engaged with two of the studs to secure the rotor assembly to the support. The support is then retracted, by turning the handwheel *D′*, to draw the rotor assembly off the cradle.

A specially developed lubricant is applied by hand to the neoprene oil seal in the rotor unit to prevent damage to this seal during assembly to the stator. Access to the oil seal is by way of the aperture in the rear bearing hub, and a convenient supply of lubricant is maintained in a felt pad within a metal container mounted on the top of the bracket *A′*.

When the concentricity check on the stator has been completed, the unit *C* is indexed to align the rotor with the stator and gearbox. In this position, the rear bearing hub *L′* is towards the stator. The handwheel *D′* is turned to traverse the work-support and rotor assembly, and the latter unit is advanced into the stator. During this movement, the rotor assembly passes over the co-axial inner and outer input shafts that project from the gearbox. As the rotor assembly is moved forward to the maximum extent, the rear bearing hub enters the bore in the inner race of a ball bearing in the bell housing (mentioned in connection with the concentricity check), and the splines on the inner and outer input shafts engage with those of the spring-drive units fitted to the front and rear inner rotor sub-assemblies, respectively.

Wiring for the solenoid, associated with the second-speed gear of the gearbox, is also fitted at the assembly station. A rubber protective cap is subsequently fitted which encloses the solenoid unit.

In the concluding article of this series, to be published shortly in MACHINERY, reference will be made to final testing of the automatic transmission unit, also to the production and testing of certain electrical components.

ELECTRICAL MEASURING INSTRUMENTS (other than supply meters and instruments for motor vehicles) produced in the U.K. during the first quarter of this year had a total value of £2,059,000, and instruments to the value of £460,000 were exported. Corresponding figures for the first quarter of last year were £1,730,000 and £365,000, and for the first quarter of 1959, £1,676,000 and £276,000.

The Manufacture of Precision Instruments

Methods Employed by VEB Carl Zeiss, Jena, East Germany

By R. E. GREEN, Associate Editor

REFERENCE TO THE HISTORY, organization, and current activities of the East German firm of VEB Carl Zeiss, Jena, was made in an article which was published in MACHINERY, 99/652—20/9/61. Among the matters there discussed were the Zeiss Foundation, established more than 60 years ago, to provide for joint ownership of the company; working conditions, and standardization of some of the multitudinous parts employed in Zeiss products, which at one time numbered about 700,000; and applications of the Mitrofanov method of grouping parts for production with common set-ups or machine lines. Attention was also drawn to a method of building jigs and fixtures from standard units for use in machining small batches of parts.

Examples of some of the more interesting production methods employed in various factories of the Group, including the large South Works, are considered here, and others will form the subjects of further articles to be published later.

THE ZEISS SOUTH WORKS

The South Works of the Zeiss organization, seen in the foreground in the heading illustration, comprise some 29 separate shops of various sizes, and provide employment for about 1,700 people, of whom 320 are women. The activities of the works, which may be regarded as one of the divisions of the Group, mentioned in the previous article, are extremely varied, and the departments include foundries for iron and light alloys, together with pattern shops, and a pressure die casting foundry for aluminium alloys, to which further reference will be made. Various shops are engaged in building special machines such as those required for cutting, grinding, and polishing of optical components, cutting super-accurate gears for use in astronomical telescopes, and for lapping gauge blocks. The production of jigs and fixtures is also undertaken.

In addition, components are made for the standardized jig and fixture building system, and a small part of the toolroom is set aside for the assembly of such jigs and fixtures. Vacuum pumps of the oil diffusion type are produced, for use in electron-beam melting units and electron microscopes, and will provide vacua of the order of 10^{-11} mm. of mercury. A gear-cutting shop supplies spur and helical gears, bevel gears, and worm drives, also high-accuracy threaded spindles for measuring instruments such as those required for photogrammetrical equipment. One such spindle,

with a thread length of 47 in., is cut with an overall pitch error of less than 0·0006 in., on a specially-constructed machine, and another special machine cuts gears as fine as 0·2 mm. module.

Other sections of the works are concerned with press work, welding, plastics moulding, the manufacture of containers and instrument cases from wood and leather, and the production of astronomical observatory domes, often in collaboration with outside contractors. Such domes vary in diameter from 10 to 65 ft., and are equipped with power drive mechanisms. So great is the demand for these varied products that much of the work has to be contracted out, and some 900,000 man-hours per year is at present being contributed by other factories in Jena and the surrounding area.

At present, the grinding of tools such as threading and milling cutters, and hobs, is carried out in the main works, which also has a centrallized heat-treatment department, but both these activities are shortly to be transferred to the South Works. Experimental work recently completed has led to the construction of special machines for engraving diffraction gratings, which are capable of cutting 600 to 800 lines per mm., and work is now in progress on a machine for cutting 1,200 lines per mm. (30,480 lines per in.). Like those for engraving scales employed in Zeiss instruments, the machines will be installed in a temperature and humidity controlled room, three storeys below ground, on vibration-insulated mountings, and arranged for operation entirely under remote control.

Other experimental work on production processes is concerned, for example, with the use of the lost wax process for making milling cutters, turbine blades, and the bodies of micrometer calipers, which will be cast with recesses for dial indicators to save machining from the solid. Efforts are also being made to extrude aluminium blanks, heated to 420 deg. C., in a 250-ton press, to a sufficient degree of accuracy to avoid the need for machining lens mounts, for instance.

THE HEAVY MACHINE SHOP

The heavy machine shop of the South Works, seen at the right in the heading illustration, serves the entire organization when operations must be carried out on castings larger than normal, or of extra heavy weight. Measuring about 510 by 115 ft., the central bay, which has a height of about 50 ft., is served by an overhead travelling crane of 9 tons capacity, and the equipment includes two planers of the type seen in Fig. 1, which were built by the Aschersleben [Thos. C. Wild (Machinery), Ltd.] factory. This machine, designated type HZ 1,800 by 6,000, has a capacity for castings up to 70 in. square by nearly 20 ft. long, and the table sliding surfaces are provided with plastics inserts.

Planing and return speeds of 82 and 148 ft. per min. are employed for the operations on the eight aluminium alloy castings shown, which are housings for a plane-grating spectrograph. The machine has tool slides on the column guideways, but only those on the cross-rail are used for the operation illustrated. Another planer of similar size was originally built by the Aschersleben factory when it was an independent organization under the name Billeter & Klunz. This machine, which was damaged by bombing during the war, was left behind by the Russians when the factory was dismantled, and was subsequently rebuilt.

The special plano-milling machine shown in Fig. 2, which was also left behind in a damaged condition, was designed and built by Zeiss in 1935, and subsequently rebuilt. Originally intended for machining castings for military range-

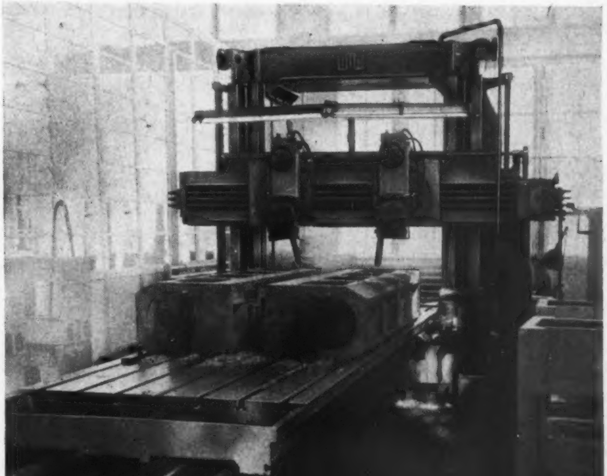


Fig. 1. This Aschersleben planer, with a capacity for workpieces up to 70 in. square by nearly 20 ft. long, is one of two installed in the heavy machine shop of the Zeiss South Works

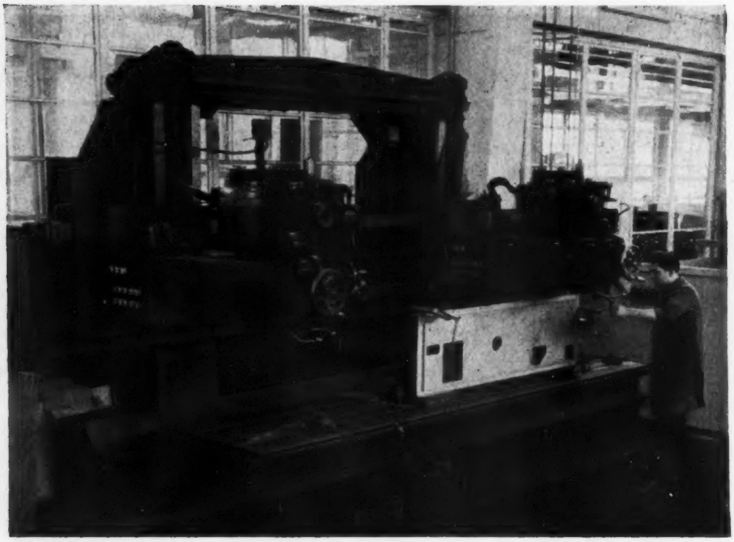


Fig. 2. This Zeiss special plano-milling machine was one of the few machines left behind by the Russians when the plant was dismantled for war reparations

finders, the machine has a table with dimensions of approximately 3·3 by 13 ft., which can be moved longitudinally under power. Behind this table there are two columns which carry a cross-rail with two spindle heads. The latter can thus be moved vertically and horizontally, and the maximum distance obtainable from the spindle noses to the surface of the table is 47 in.

There is a choice of six speeds for each spindle, ranging from 18 to 467 r.p.m., drive being taken from a pole-changing motor, through V-belts. Although limited in its applications, the machine is effectively employed for certain work, and is seen set up for face milling an aluminium base plate for an infra-red spectrophotometer.

In Fig. 3 is shown a small open-side planing machine, built by the Blell factory in Zeulenroda. This machine has a table measuring about 9·8 by 2·6 ft., which is here loaded with 16 iron castings for optical dividing heads. These castings have been rough machined at a previous operation, and are here being finished on one of the side faces, with a fine feed and cut, by tools on the cross-rail. At the same time, the mounting faces of eight of the castings are being planed with a tool on the column.

Fig. 3. Blell open-side planer set up for operations on iron castings for precision dividing heads

AUTOMATIC CYLINDRICAL LAPPING MACHINE

Cylindrical supporting elements, employed in the Zeiss universal measuring machine, rest in two

Fig. 4. Special machine built by Zeiss for finish lapping operations on the part - cylindrical guideways of table castings for universal measuring machines. Laps finished by metal-spraying are employed without abrasive

guideways of matching cylindrical form in a table casting, seen at the right in Fig. 4, which also shows the special machine designed and built by Zeiss for finishing these ways by lapping. The part-cylindrical ways are first rough-machined on a planer by means of a special tool-holder fitted to one of the cross-rail heads. This holder is arranged to swivel through the required angle and the cylindrical form is thus produced. This operation is carried out on six castings at one setting, which are arranged in line on the Billeter planer mentioned above, each casting having an overall length of 39·4 in.

The castings, which are of fine-grained iron, are then annealed and artificially aged by heating to 680 deg. C., holding them at this temperature for three hours, and then cooling at the rate of 50 deg. per hour. After they have cooled, the castings are cleaned by shot blasting, painted, and finish planed at a similar set-up. Lapping is then carried out in roughing and finishing stages, to bring the part-cylindrical ways, which have a nominal radius of 55 mm. (2·165 in.), to the required degree of smoothness and straight within 0·002 to 0·004 mm. (0·00008 to 0·00016 in.), over the full length. The diameter dimension is of rather less importance, since the mating elements can be ground to match, but the finished surfaces must be very smooth and free from blemishes to pass the rigid inspection demanded.

The rough lapping operation is carried out on a machine similar to that shown in Fig. 4, but is of shorter duration. For this reason, the finishing machine illustrated is of the duplex type to enable two tables to be lapped simultaneously for a longer period. This machine was built from a disused lathe, and from the headstock, here seen at the right, drive is transmitted by roller chains to the two lapping spindles, which are supported in bearing brackets at each side of the bed. At the centre of the bed there is a structure, with sheet metal covers, which houses two cylindrical guide rods, arranged one above the other.

On these rods there is a sliding saddle, connected by a link-bar to an eccentric pin on a disc within the circular housing at the right. The disc, also, is driven from the lathe spindle, and as it rotates, the saddle is moved horizontally on the guide rods through a fixed stroke. Outrigger brackets on the saddle carry bars to which the tables to be lapped can be fastened, and they rest on the laps by their own weight. The laps rotate continuously, at slow speed, and the tables are moved at the rate of one double stroke in 7 sec.

For the roughing stage, the lap is charged with fine emery abrasive, which is thoroughly washed off prior to finish lapping. For the latter operation, no abrasive is employed. Each lap is machined slightly under-size and is then built up above the required diameter by spraying with steel, and ground to size. The hardness and abrasiveness of the steel deposit thus obtained suffice to remove the very small amounts of material remaining on the guide surfaces. Since the guideways do not extend through the central portions of the tables, it is possible to support the laps at their central positions my means of screw jacks, to prevent them from sagging under their own weight.

In addition to the machines mentioned, the heavy machine shop is equipped with horizontal and vertical borers, large lathes and grinders, and a variety of machines of intermediate size. At one

end, there are facilities for cutting and welding steel plate to produce fabricated structures, and another area is devoted to the scraping of guide surfaces on a variety of castings, mainly for precision measuring machines. Plans are in hand for building a second heavy shop of similar dimensions, which is to be completed by the end of 1962.

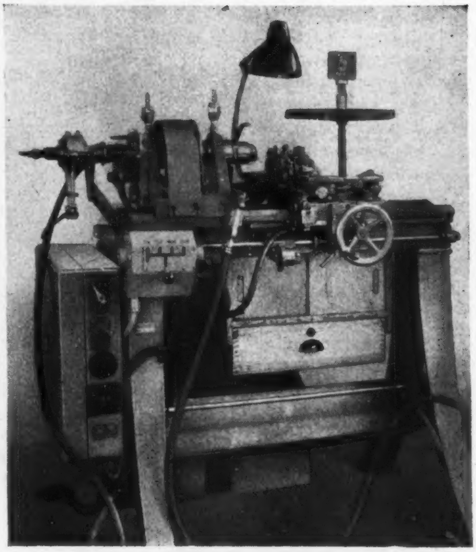


Fig. 6. The type RB 34 lathe, developed by Zeiss, is intended for the production of instrument components and has an 8-sided tool turret

DIE CASTING FOUNDRY

The die casting foundry in the South Works was established in 1935, and is housed in a rectangular building with a die store at one end. There are eight Czechoslovakian Polak (Elgar Machine Tool Co., Ltd.) machines of 250 and 350 tons locking capacity, of the direct-hydraulic type. These machines are operated by water and oil emulsion which is supplied under a pressure of about 1,800 lb. per sq. in. from pumps and accumulators in a cellar beneath. Because of the high level of demand for castings, the foundry has been operated on a 3-shift basis almost since its inception and the plant is used more intensively than any other in the factory.

Two main aluminium alloys are cast in the foundry, one of which (Silumin) contains up to 13 per cent of silicon, and the other (Hvdronalium) 7 to 9 per cent of magnesium. Bulk melting is carried out in gas-heated crucibles and in two electrical-resistance type furnaces, each with a capacitv of 1,320 lb. of aluminium, which can be melted in about 6 hours from cold. The molten metal is transferred to the gas-fired holding furnaces by means of large ladles. A wide variety of components for Zeiss products is made in the foundry, including simple housings and fairly complicated castings, but the use of moving cores appears to be avoided as far as possible in the interests of die simplification.

Fig. 5. Typical of the tools employed in the pressure die casting foundry is this die for a camera body, seen set-up on a Polak vertical injection plunger machine

It is claimed that whereas some companies normally obtain only 30,000 to 50,000 castings from a die costing 20,000 marks (£1,800), the Zeiss foundry, by thorough maintenance and care of the tools, can produce as many as 150,000 castings per die. Many castings are supplied to the factories of the East German camera industry, now concentrated in and near Dresden, and a typical die for a camera body, which incorporates moving cores, is seen in Fig. 5, in position on a 350-ton Polak machine. This die has two horizontally-moving cores, operated by hydraulic cylinders at the sides, for the top and bottom of the body, and a

third core, operated by a cam pin, which is moved vertically to produce a cavity in the end face.

The hydraulically-operated cores are guided in V-surfaces machined in the opposing die faces, and are locked in position, when the die is closed, by tenons on the face of the fixed half at the right, which enter slots in the slides. The die shown is gated at the centre of the film aperture portion of the casting, and a small runner tapering from 0·75 to 0·5 in. diameter over its length of about 6 in. is employed. Manually-operated, mechanical ejection is used on this die, and on most of those employed in the foundry. In addition to the eight Polak machines mentioned, there is a number of smaller units, also manually-operated gravity die casting machines which are mainly employed for making magnesium alloy castings.

An interesting production technique observed in the foundry was the casting of thin-walled parts of conical shape from aluminium alloy in a semi-crystalline state in order to obtain smooth surfaces on the finished castings. For this purpose, ladles are filled and put aside to cool, six being constantly in use, and the ladle which has stood for the longest period is used for the casting. The semi-crystalline metal, in a plastic condition, has to be virtually pushed into the shot sleeve rather than poured, and it was noted that the resulting castings had very smooth outside contours.

ZEISS RB 34 INSTRUMENT LATHE

Large numbers of the parts made by Zeiss, particularly for optical instruments, are bush- or ring-shaped, usually with one or more fine threads, and a drum-turret type of lathe, designated RB 34, has been developed by the company for the production of such parts. Such lathes are employed in most of the Zeiss machine shops, and an example is shown in Fig. 6. It has a cast iron bed, supported on stands of the same material, and at one end, the bed has V- and flat surfaces on which the adjustable headstock is located. A cupboard with sliding doors and a drawer are attached beneath the bed to hold tools, books, and drawings.

The headstock spindle runs in plain bearings and is driven by a V-belt from a floor-mounted motor at the rear of the machine. Four-step cone pulleys are employed, in conjunction with a pole-changing motor, to give a range of 16 spindle speeds if required. For normal purposes, only the range of four speeds provided by the pole-changing motor is employed, and selection is made by means of a switch at the front of the bed beneath the headstock, as seen in the close-up view in Fig. 7. The switch has a lever which can be moved through a gate to any of six positions, and when it is pushed downwards in the central slot of the gate the current supply to the motor is cut off and the air-operated chuck is opened.

The action of raising the lever to the height of the central horizontal slot operates a pneumatic valve to close the collet, as will be described. The lever can then be moved laterally and raised further into one of the vertical slots above, which are marked with the speeds obtainable from the pole-changing motor for the particular pulley step in use, and range from 500 to 1,500 r.p.m., on the machine shown in the figure.

By moving the lever along the central slot to the left-hand end, and pushing it downwards into the vertical slot at that end, a reverse speed of 750 r.p.m. is engaged.

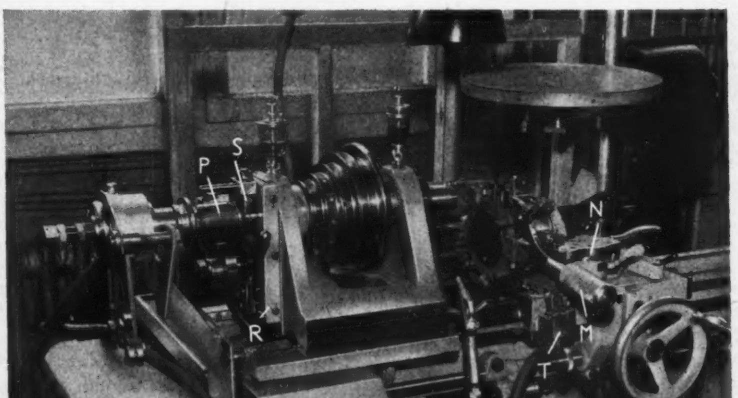


Fig. 7. Close-up view of the RB 34 lathe showing the arrangement of the turret tools and the equipment for thread-chasing operations, which are carried out under the control of the threaded, hardened steel bush *P*

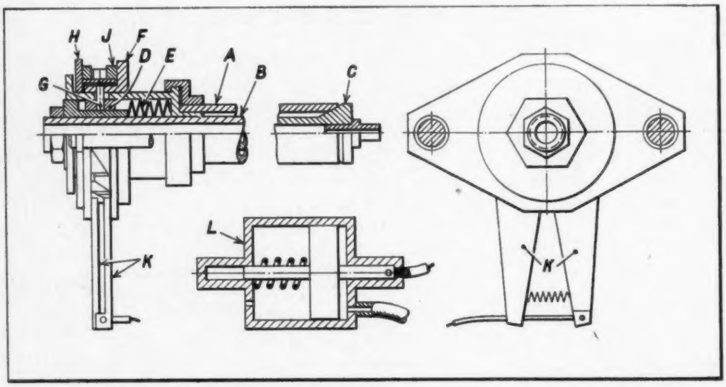


Fig. 8. Sectional views showing the arrangement of the collet-closing and -opening equipment on the RB 34 lathe. A brake is automatically applied to the spindle as the collet is opened

The spindle is fitted with a collet chuck, actuated by an air-operated mechanism, which provides for automatically braking the spindle as the collet is opened. For closing the chuck, there is a series of Belleville washers surrounding the spindle, so that in the event of failure of the air supply, the chuck cannot open accidentally while rotating. The arrangement is shown by the part-sectional views in Fig. 8, and the spindle, indicated at *A*, contains the hollow draw-tube *B*, connected to the collet *C*. A bush surrounding the left-hand end of the draw-tube carries a threaded collar *D*, which can be adjusted axially to vary the force applied to the collet up to a maximum of about 220 lb.

Closing force is exerted between the draw-tube retaining nut at the left-hand end, and a housing secured to the spindle and containing the Belleville washers. On the outside of this housing there is a flanged bush *F*, which is connected by a pin *G*, passing through a slot in the housing, to the threaded collar *D* on the draw-tube bush. A second flanged bush, *H*, surrounds the first, and has extended ears at opposite sides through which pass guide pins secured to a bracket projecting upwards at the end of the lathe bed, as seen in Fig. 7. The guide pins prevent rotation of the bush *H*, but permit limited axial movement. Between the flanges of the two bushes *F* and *H*, and supported on the outside of the latter, are two discs *J*, each with a series of ratchet—or buttress-shaped teeth. These teeth are on the inner faces of the discs, and the two sets engage two levers *K*, attached to the discs, that extend downwards beneath the spindle, and are connected to the single-acting, spring-returned piston of the air cylinder *L*, by a flexible cable. The levers *K* are lightly spring-loaded apart, and when the collet is closed by the action of the Belleville washers the teeth of the discs *J* are brought closely into mesh. When air pressure is admitted to the cable end of the air cylinder *L*, the movement of the piston is transmitted through the cable and serves to draw the two levers together, with the result that the two discs *J* are turned in opposite directions. This movement causes the sloping surfaces of the teeth on the discs to ride over one another, and that the right-hand disc is thus moved to the right, and pressed against the flange of the inner bush *F* to brake the free-wheeling spindle.

At the same time, the bush *F* transmits thrust through the pin *G* to the bush surrounding the draw-tube. Consequently, the bush is moved to the right, compressing the Belleville washers, and the closing force on the collet is released. The workpiece can then be removed from the collet, and another part loaded, as the spindle comes to rest.

Tools for turning, boring, facing, recessing, and thread-chasing operations are mounted on eight T-slotted flat faces on the periphery of the turret, as seen at the right in Fig. 7. For indexing the turret, there is a large knurled handle *M*, which is held on a projection from a ring, engaged with a deep groove in the body. The handle is attached to a spring-loaded plunger which passes through the ring and can be engaged with one of a series of locating holes in the turret. By pulling the handle outwards, the plunger is disengaged and the ring can then be turned until the plunger enters the next hole in the turret.

Adjustable stops on dovetail surfaces to the right of the ring are employed to position the tools in the required relationship to the work, to suit the diameters to be produced. These stops are brought into contact with the face of a plate *N*, which is mounted on a vertical pivot, and held in alternative positions by means of a spring-loaded detent lever beneath. The stops, of which there are two for each turret face, can thus be

brought successively into contact with the plate *N*, to provide two alternative positions for each turning tool, so that different diameters can be machined on the work.

Turning and boring operations are performed by bringing the tools into positions determined by the appropriate stops, and traversing the saddle, either by hand or power. For a facing or recessing operation, the saddle is positioned longtudinally by a stop, and the turret is then turned manually to feed the tool.

SEMI-AUTOMATIC THREAD-CHASING MECHANISM

The machine is also fitted with semi-automatic thread-chasing equipment developed by Zeiss, whereby the saddle is traversed longitudinally under the control of a fine-threaded hardened-steel bush on the rear end of the spindle, as seen at *P* in Fig. 7. Provision is made for changing this bush when a thread of a different pitch is required. All threads are thus cut under leadscrew control, and the need for change-gearing and selector mechanisms is avoided. At the rear of the headstock there are guideways for a vertical slide *R*, which is moved down, against the action of a compression spring, by an air cylinder, and has an elongated hole surrounding the machine spindle.

When the slide is in the lowered position, in which it is held by a lever, the thrust block S is engaged behind a collar on the spindle so that axial movement is prevented. Beneath the spindle the slide is provided with a spigot on which is mounted a brass wheel, with six part-circular grooves in the periphery. The surface of each groove is machined with a thread of the same pitch as the thread on the bush *P*, and the arrangement is such that a fresh threaded portion can be brought into use quickly, when wear occurs. When the slide is raised by the action of the spring mentioned earlier, the uppermost threaded groove is engaged with the thread of the bush *P*, and at the same time the thrust block S is raised clear of the collar.

The spindle is then caused to move forward axially at a rate corresponding to the pitch, and with one of the turret chasing tools in position a thread is cut on the work. Retraction of the tool at the end of each pass is effected by means of a vertical single-acting air cylinder in the housing *T* on the saddle. The ram of this cylinder is located directly beneath the extension of the turret indexing ring whereon the handle *M* is carried, and is provided with a pivot-piece which can be folded down clear of the knob if thread cutting is not being performed.

When the air cylinder in the housing *T* is energized, the ram moves upwards, lifting the handle *M* and turning the turret so that the tool is carried clear of the work. For control of the simultaneous air supply to the two cylinders, equipment is installed at the rear of the spindle head, as seen in the close-up view in Fig. 9. The housing *U* contains a rotary valve, the spindle of which is normally prevented from turning by means of a pawl (not shown). This housing also carries the slotted horizontal slide *V*, with two rollers which can be adjusted to any required position.

The rollers are located one on each side of a collar *W*, secured to the spindle, and as the latter is moved axially during the thread-chasing opera-

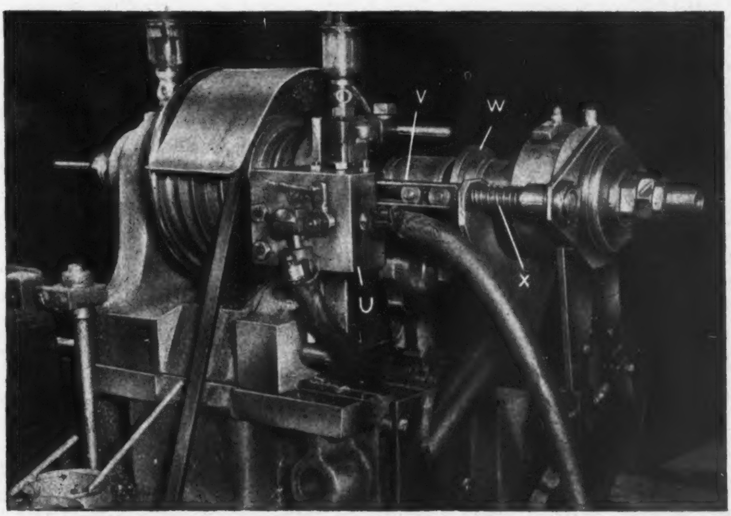


Fig. 9. The point at which the thread-chasing tool is retracted from the work, and the follower is disengaged from the leadscrew, is controlled by one of two adjustable rollers on the slide *V*, which operates a rotary air valve in the housing *U*

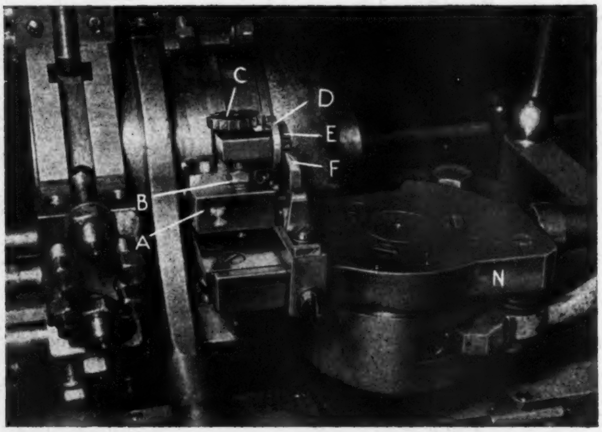


Fig. 10. During thread-cutting, feed increments are applied manually, or automatically by means of this ratchet-operated mechanism mounted at one of the stop-holding positions on the tool turret

tion, the collar *W* is brought into contact with the left-hand roller, to move the slide to the left and displace the pawl. This action allows the spindle of the rotary valve to be turned by a tension spring on the outside of the housing, and air is then admitted to the two cylinders simultaneously, to retract the nut-wheel from the threaded bush and the tool from the work. The spindle is now returned to the right (in Fig. 9), by the action of compression springs on the guide pillars *X*, for the bush *H* (Fig. 8), and the rotary valve spindle is re-set by the slide *V*, which is returned by the second roller.

Adjustments for the length of thread are made by means of the rollers on the slide *V*, the positions of which determine the starting and stopping points for the threading passes. The depth of thread may be controlled by the operator with the aid of a knurled screw in the stop bracket on the turret, the screw being turned during the return motion of the spindle, to permit the tool to advance slightly for the next pass. Equipment has, however, been developed, whereby increments of feed can be automatically applied, and is shown in Fig. 10, where the pivoted plate, against which the turret stops act, is again seen at *N*.

Secured to the dovetail ways of the turret, to the right of the ring for the indexing lever, is the bracket *A*, which has a nearly-horizontal portion with a tapped hole for the feed screw *B*, the lower end of which is just visible, resting on the face of the plate *N*. When this screw is turned, the turret is rotated slightly, to move the single-point tool, on the far side, towards or away from the work. Another portion of the bracket has a bore for a shaft which is connected to the screw, and at the top of this shaft there is a ratchet wheel *C*. The teeth of this ratchet are engaged by a pawl in a slot at one side of the bracket, so that the screw is turned slightly at each operation of the pawl.

Movements are imparted to the pawl by a series of projections on the side face of the disc *D*, which is mounted on a horizontal shaft at the side of the bracket, and keyed to a second ratchet wheel *E*. At the front of the plate *N* is fastened another bracket, holding a spring-loaded pawl *F*, the upper end of which is engaged with the teeth of the ratchet *E*. At the end of each thread-cutting pass, when the turret is rotated by the air cylinder in the housing *T*, Fig. 7, the bracket *A*, Fig. 10, is lifted slightly as the tool is retracted from the work. The ratchet wheel *E* is retained in position by a second sprung pawl at the rear, and the front pawl *F* rides over one of the teeth, and engages the next space.

Subsequently, the turret is returned by cutting off the air supply to the tool-retraction cylinder, and as it moves down, the ratchet wheel *E* is turned through one space by the front pawl *F*, to apply an increment of feed.

Other examples of Zeiss production methods will be described in articles to be published in future issues of MACHINERY.

AN UNUSUAL RECOVERY SYSTEM FOR MILL SCALE containing valuable alloying elements has been designed and installed by Michael & Partners, Ltd., 26 Chatsworth Road, Chesterfield, for the new intermediate rolling mill at the works of Samuel Fox & Co., Ltd., Stocksbridge. Scale from the rolls is carried by water into the scale pit beneath the mill, and over a weir into a settling pit, from which it is dredged by one of two crane-operated grabs, and deposited in a skip. The grabs are of the self-trimming type, originally designed for complete unloading of coal from railway wagons, and the width of the flat bottom of the pit is only 2 in. greater than the full width of the grabs, thus ensuring almost complete recovery of the scale.

Rubery Owen-Swift Cupping Test Press

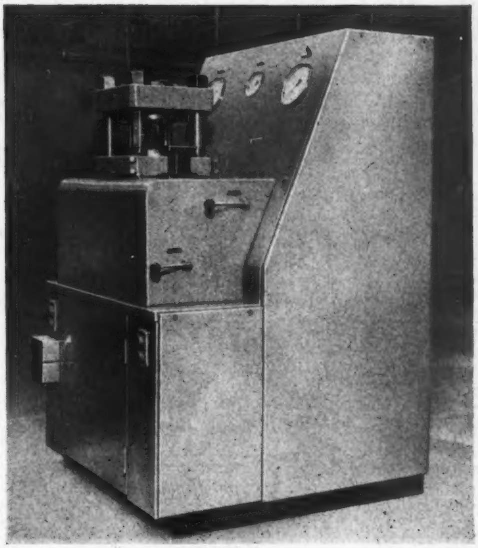


Fig. 1. Rubery Owen-Swift hydraulically-operated cupping press

The Research and Development Department of Rubery Owen & Co., Ltd., Darlaston, Staffs., have developed a compact machine, illustrated in Fig. 1, for use in deep drawing research and primarily for performing Swift cupping tests under controlled conditions. Basically, the machine is an inverted hydraulic press, the ram being designed to apply force to the punch in an upward direction, and the specimen being held in a blankholder mounted beneath a die.

Normally, the pressure on the ram is derived from a hydro-pneumatic accumulator, and drawing speeds of 1 ft. to 100 ft. per min. can be obtained by this method. Alternatively, the ram may be operated directly from a motor-driven pump rated at 2 gall. per min. The maximum force exerted by the punch is 37 tons and the load on the blankholder, which is maintained constant throughout the period of the draw, may be of any value from zero to 8 tons. This load is applied pneumatically, and an air reservoir is included in the circuit to avoid any increase in pressure caused by thickening of the edges of the specimen blank during the drawing cycle. The table on which the blankholder unit is supported can be raised or lowered to any convenient height by a small independent hydraulic pump connected to an auxiliary ram.

Tools employed on the machine conform to the specifications of the International Deep Drawing Research Group for the Swift cupping test, the punches and dies being made from steel of high carbon, high chromium content, which has a hardness, after heat treatment, of 60 Rockwell C. Generally, the punches have hemispherical or flat heads, and diameters of 32 mm. or 50 mm., the choice depending on the thickness of the material to be tested and the method of pressing that is to be employed. The former type of punch is suitable for testing material that is to be subjected to considerable stretching, whereas the latter type is intended to provide test conditions which are similar to those encountered in deep drawing. With the Swift test, an assessment of the drawing quality of sheet metal is made by determining the maximum diameter of blank that can be drawn into a cup without fracturing.

Test specimens, cut to approximate dimensions by shearing, are turned to the required diameter while held in a fixture, and then deburred. Before

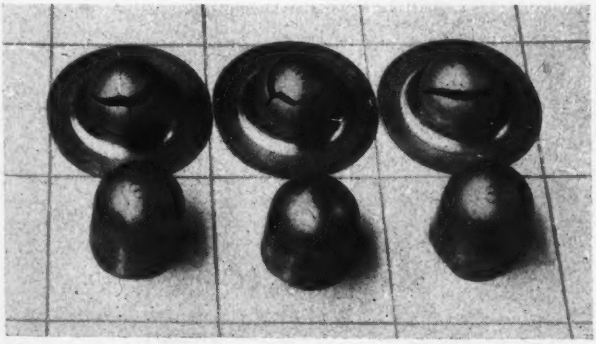


Fig. 2. Results of cupping tests on samples from two batches of material used in a press shop

being tested, each specimen is measured for thickness, degreased, and coated with thin film of suitable lubricant, such as Esso T.S.D. 996. During the testing sequence, cups are drawn from a range of blanks selected in increasing order of size until a failure of material occurs. At least three blanks are then drawn at this size and at other sizes immediately above and below, to establish the diameters at which all cups fail, and all are fully drawn. When an accurate measurement of a drawing load is required, a strain gauge load cell is inserted behind the die and the signal produced is fed to an oscilloscope or a dynamic strain pen recorder to provide a load/displacement trace for the complete cycle.

Fig. 2 shows the results of Swift tests carried out in connection with a particular press-shop problem. It was necessary to determine whether a particular material was suitable for a specific operation in the manufacture of a fuel tank top, which was to be pressed by a combination of deep drawing and stretching techniques. A punch with a hemispherical head was therefore selected, and a series of blanks of different diameters was prepared. As the diameter of the blanks increased, failure of the specimens occurred. The lower row of test pieces are all from 4·50-in. diameter blanks, and the upper row from 4·55-in. diameter blanks. A clear indication of the sensitivity of the method is thus afforded.

From experience so far gained, it appears that correlation of cupping tests and press shop operations is reasonable. It must be emphasized, however, that the results of such cupping tests should be interpreted against a background knowledge of deep drawing and pressing operations in order to avoid the always-present danger that academic research can become divorced from practice.

Profile Milling a Spider for a Gyroscope Rotor on a Gorton Machine

At the works of the American Bosch-Arma Corporation, Garden City, N.Y., U.S.A., a Gorton type P2-3 3-dimensional pantograph engraving machine is being used for the batch production of high precision components for guided missiles. One example is a cast aluminium spider for a gyro-rotor, as seen at *A* in the accompanying illustration. In service, this component runs at high speed and must be very accurately in balance. It is therefore machined all over from the solid. It may be noted that a steel bush is cast in, to receive a hub. As may be seen in the illustration, the component is in the form of a wheel with spokes, but the latter are of stepped, cross section, and joined by a web.

For machining each triangular-form pocket, the outer path of the template is first followed, with a down feed of 0·015 in. per pass. After the step depth has been reached, the operator changes the stylus to the inner path of the template, and continues the profiling cuts down to web depth, which must be held to a tolerance of 0·002 in. It is stated that with the Gorton machine the profiling is performed in about one-sixth of the time required by the previous method.

The sole agents in this country for the George Gorton Machine Co. are Alfred Herbert, Ltd., Coventry.

Set-up on a Gorton pantograph engraving machine for profile milling cast aluminium spiders for gyro-rotors at the works of the American Bosch-Arma Corporation

Evaluation of the Effects of Spline Misalignment

By EARLE BUCKINGHAM

SPLINED SHAFTS are used both for tight-fit permanent assemblies and in sliding-fit connections with mating couplings. In the first application, the splines serve as multiple keys and there is substantially full surface contact between the mating members, so that if failure occurs it is generally by torsional shear of the shaft below the roots of the splines rather than as a result of any failure of the splines themselves.

With splines of the clearance-fit, or sliding type, on the other hand, failure may occur in other ways, including shear of the splines, compression of the splines, breakage at the roots of the splines due to bending, wear due to fretting corrosion, and bursting of the female splined member on account of radial, tangential, and centrifugal stresses. The probability of failure in one or other of these ways is greatly increased by any misalignment of mating splines. It is therefore of some importance that the quantitative effects of misalignment should be understood, and that due allowance for such effects should be made in the design. Factors such as spline imperfections and spacing errors which also have an effect on load and stress distribution, will not be considered here.

CONTACT BETWEEN MISALIGNED SPLINES

When the alignment of slidably connected shafts is theoretically correct, substantially surface contact conditions are obtained between teeth of the mating members, as in the case of tight-fit assemblies. Under these conditions the load capacity is substantially the same as for permanent assemblies. Surface wear, if it does occur, will be largely limited to fretting corrosion that may develop from slight axial movement between the mating splines due to such factors as torsional deflection in operation.

If misalignment is present, however, the conditions are quite different from those of full surface contact, and the potential load-carrying capacity is reduced with increasing amounts of misalignment more rapidly than is generally appreciated. With misalignment, contact is confined to two splines only. If the splines are not crowned, and if the materials were regarded as being perfectly rigid, there would be edge or corner contact. One driving spline would make contact at one end of the spline or coupling—whichever was the shorter—and the other driving spline contact would be diametrically opposite to the first, but at the other end of the spline or coupling. Adjacent teeth would have clearance, the amount of which would increase as the angular distance from the driving spline increases.

No material is perfectly rigid, however, and elastic deformation will result in surface engagement adjacent to the contacting edges, but with decreasing load intensities as the distance from the edges increases. When the amount of elastic deformation of a driving spline is greater than the clearance between any adjacent splines there will also be contact on these splines, but the amount of load which they carry will be less than that on the initial driving spline.

DETERMINING CLEARANCES AND INTERFERENCES WITH MISALIGNED SPLINES

The first step in making an analysis of load distributions resulting from misalignments of driving splines is to determine the amount of the clearances, or interferences, between the other splines in the spline connection. The following symbols will be used in the analysis.

Δ = angle of misalignment;
ϕ = angle of spline at mid-depth (pressure angle of involute spline);
θ = vectorial angle of centre line of spline, measured from "hinge" of misalignment;
N = number of splines;
F = face, or length of engagement of spline, in.;
R_1 = radius to mid-depth of spline, in.;
C = amount of clearance between mating splines, in. (When the value of C is minus, there is interference);
C_1 = corrected value of clearance when the clearance on the driving spline is zero.

When a straight spline is misaligned, one end is lifted above the centre line and the other end is dropped, as shown in Fig. 1. The "hinge" of the misalignment falls at a point that is midway along the length of engagement. Presented in

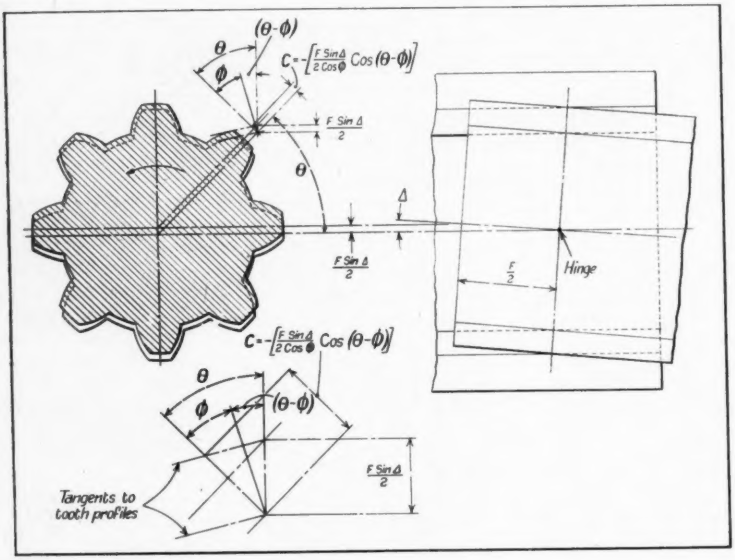


Fig. 1. Clearance and interference conditions resulting from angular misalignment of splines

the following equation are the values of the interferences ($-C$) and the clearances ($+C$) for various splines when the mating members are misaligned:

$$-C = (F \sin \Delta/2 \cos \phi) \;............\; (1)$$

When the values of F, Δ, and ϕ are fixed, they become constants in Formula 1; the values of C and θ remain variables. The value of the derivative $dC/d\theta$ gives the rate of variation of the values of the clearances. When this value is equal to zero, then the clearances are at a maximum or minimum value.

$$(dC/d\theta) = F \sin \Delta/2 \cos \phi \;.........\; (2)$$

When $dC/d\theta$ in this equation is made equal to zero, then, since the value of ($F \sin \Delta/2 \cos \phi$) is finite and fixed, the value of $\sin (\theta - \phi)$ must be equal to zero. Therefore,

$$\theta - \phi = 0 \text{ deg. and } 180 \text{ deg.}$$
$$\theta = 0 \text{ deg.} + \phi \text{ and } 180 \text{ deg.} + \phi \;...\; (3)$$

One of these values of θ represents the position of maximum interference, and relates to the driving spline in the counterclockwise direction of rotation, as shown in Fig. 1. The other angular value represents the position of the spline with the maximum amount of clearance, and this position is at 180 deg. from the driving spline.

Theoretically, there is a geometric factor which shifts these angular positions very slightly. The tipping of the internal spline through the angle Δ changes the angular relationships of the splines on the internal member because it produces an elliptical projection in the plane of rotation of the coupling member. However, since the angles of misalignment here being considered are only very small fractions of a degree, this effect can be ignored.

ELIMINATING INTERFERENCE BETWEEN SPLINES

In order that misaligned splines can mate without any "cramping" of the teeth, it is necessary to reduce to zero any interference resulting from the misalignment. This result may be achieved by increasing the width of the spline spaces of the female splined member or decreasing the thickness of

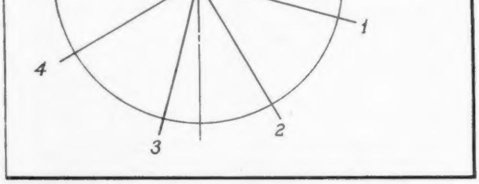


Fig. 2. Method of numbering spline positions of an 8-spline straight member. The 0 indicates the position of maximum interference. The two teeth on either side of the 0 position both have the same amount of clearance and both are designated 1. The same applies to the remaining teeth. Tooth position 4, opposite position 0, has maximum clearance

TABLE 1. CALCULATION OF CLEARANCES FOR 8-SPLINED MEMBERS OF 4/8 PITCH, 30-DEG. PRESSURE ANGLE, 2-IN. LENGTH OF ENGAGEMENT, AND 0·05-DEG. MISALIGNMENT ANGLE

Tooth No.	θ	(θ-30 deg.)	COS (θ-30 deg.)	C	C_1
0	30	0	+1·000	−0·00100766	0
1	75	45	+0·70710678	−0·00071252	0·00029514
2	120	90	0	0	0·00100766
3	165	135	−0·70710678	+0·00071252	0·00172018
4	210	180	−1·000	+0·00100766	0·00201532
3	255	225	−0·70710678	+0·00071252	0·00172018
2	300	270	0	0	0·00100766
1	345	315	+0·70710678	−0·00071256	0·00029514

the splines of the male member. In either case, whatever the amount of backlash required to reduce the interference to zero at the position of maximum interference, the same amount must be added to the clearance, or interference, at every other position. It follows that the minimum amount of backlash that needs to be provided to prevent cramping is equal to the clearance plus the interference at the position of maximum interference.

EXAMPLES OF THE USE OF THE FORMULAE

In the examples that follow, standard 30-deg. involute splines will be used to illustrate the application of the formulae. In these examples, a 2-in. pitch diameter and a 2-in. length of engagement will be maintained for purposes of comparison:

$N = 8$; pitch $= 4/8$; pitch diameter $= 2$ in.; length of engagement $F = 2$ in.; pressure angle $\phi = 30$ deg., and $\Delta = 0{\cdot}05$ deg.

$\theta = 0 + 30 = 30$ deg. and $\theta = 180 + 30 = 210$ deg.

With eight-splines, the angular spacing of the teeth is 45 deg. When the driving spline (the spline with maximum interference) is identified it is numbered 0. The two adjacent splines are both numbered 1, and so on, as indicated in Fig. 2. The clearance conditions are symmetrical, so that all splines with the same numbers have the same amount of clearance.

The calculations for the clearances of this 8-spline member are given in Table 1.

$$C = -(F \sin \Delta/2 \cos \phi) \cos (\theta - \phi)$$

$$\cos \phi = 0{\cdot}8660254$$

$$\sin \Delta = 0{\cdot}00087266$$

$$C = -0{\cdot}00100766 \cos (\theta - 30 \text{ deg.})$$

In this first example, the driving spline is at 30 deg. with an interference of $C = -0{\cdot}00100766$ in. when $\Delta = 0{\cdot}050$ deg. In order to bring the value of C_1 to zero on the driving spline, the amount of this maximum interference must be added to other values of C. The corrected values, or clearance values, are denoted as C_1. These clearance values C_1 are shown in the sixth column of Table 1, and range from zero on the driving spline to 0·00201532 on spline No. 4, and back to zero again.

Particular care must be exercised to use the plus or minus sign of the trigonometric functions correctly, depending upon the quadrant.

Values for C_1 for misalignment angles of 0·050, 0·100, 0·150, 0·200, 0·250, and 0·500 deg. have been calculated in the same manner and are tabulated in Table 2. The amount of clearance increases with an increase in the misalignment angle and is substantially directly proportional to that angle, since for small values the sine of the angle is nearly equal to the angle itself.

The minimum backlash needed to permit the specified angle of misalignment without cramping is equal to the maximum clearance on spline No. 4. This is equal to 0·00201532 in. for the 0·050-deg. misalignment. The allowance on the outside diameter of the male member must equal

$$F \sin \Delta \quad \text{(4)}$$

as may be seen from Fig. 1. This amounts to about 0·00175 in. for the 0·050-deg. misalignment.

In operation, each pair of mating teeth will carry its maximum load as it passes through the angle of θ_0 which is the position of the driving tooth. When the elastic deformation of the teeth at the driving-tooth position is greater than the amount of the clearance at other positions, a lesser load will be carried in that position, since some of the total load transmitted will then be carried by teeth at these other positions. When the amount of clearance at other positions is greater than the elastic deformation at the driving position, no load will be carried at those other positions. Thus, as the shaft rotates, the load on each spline will vary from a minimum or zero value, rise to a maximum, and then fall again. During this rotation, there will also be a small amount of sliding in an axial direction because of the misalignment. The amount of this sliding will increase as the angle of misalignment increases.

In addition to the data for eight splines computed in the first example, values for 16 and 32 teeth have been determined and have been tabulated in Table 2 for convenient comparison. It should be noted that regardless of the number of

TABLE 2. CLEARANCES ON 8-, 16-, AND 32-SPLINED MEMBERS OF 30-DEG. PRESSURE ANGLE, WITH 2-IN. LENGTH OF ENGAGEMENT

Tooth No.	Misalignment Angle, Δ deg.					
	0·05	0·10	0·15	0·20	0·25	0·50
	Clearance, C_1, in.					
	8 Teeth, 4/8 Pitch					
0	0	0	0	0	0	0
1	0·00029514	0·00059028	0·00088541	0·00118055	0·00147569	0·00295137
2	0·00100766	0·00201532	0·00302299	0·00403064	0·00503830	0·01007659
3	0·00172018	0·00344036	0·00516057	0·00688072	0·00860093	0·01720180
4	0·00201532	0·00403064	0·00604598	0·00806132	0·01007662	0·02015323
	16 Teeth, 8/16 Pitch					
0	0	0	0	0	0	0
1	0·00007670	0·00015340	0·00023010	0·00030680	0·00038350	0·00076700
2	0·00029514	0·00059028	0·00088541	0·00118055	0·00147569	0·00295137
3	0·00062205	0·00124410	0·00186615	0·00248820	0·00311025	0·00622049
4	0·00100766	0·00201532	0·00302298	0·00403064	0·00503830	0·01007659
5	0·00139327	0·00278654	0·00417981	0·00557308	0·00696635	0·01393269
6	0·00172018	0·00344036	0·00516054	0·00688072	0·00860090	0·01720180
7	0·00193862	0·00387724	0·00581586	0·00775448	0·00969310	0·01938619
8	0·00201532	0·00403064	0·00604598	0·00806132	0·01007662	0·02015323
	32 Teeth, 16/32 Pitch					
0	0	0	0	0	0	0
1	0·00001936	0·00003872	0·00005808	0·00007744	0·00009680	0·0019360
2	0·00007670	0·00015340	0·00023010	0·00030680	0·00038350	0·00076700
3	0·00016982	0·00033964	0·00050946	0·00067928	0·00084910	0·00169820
4	0·00029514	0·00059028	0·00088541	0·00118055	0·00147569	0·00295137
5	0·00044783	0·00089566	0·00134349	0·00179132	0·00223915	0·00447830
6	0·00062205	0·00124410	0·00186615	0·00248820	0·00311025	0·00622049
7	0·00081108	0·00162216	0·00243324	0·00324432	0·00405540	0·00811080
8	0·00100766	0·00201532	0·00302298	0·00403064	0·00503830	0·01007659
9	0·00120424	0·00240848	0·00361272	0·00481696	0·00602120	0·01204240
10	0·00139327	0·00278654	0·00417981	0·00557308	0·00696635	0·01393269
11	0·00156749	0·00313498	0·00470247	0·00626996	0·00783745	0·01567490
12	0·00172018	0·00344036	0·00516054	0·00688072	0·00860090	0·01720180
13	0·00184550	0·00369100	0·00533650	0·00738200	0·00922750	0·01845500
14	0·00193862	0·00387724	0·00581586	0·00775448	0·00969310	0·01938619
15	0·00199596	0·00399192	0·00598788	0·00798384	0·00977980	0·01995960
16	0·00201532	0·00403064	0·00604598	0·00806132	0·01007662	0·02105323

splines the maximum clearance for any given misalignment angle, diameter of spline, and length of engagement remains the same; but with greater numbers of splines, the increments of clearance between successive teeth are smaller.

RELATION OF LENGTH OF ENGAGEMENT TO CLEARANCES

For any given angle of misalignment, the amount of the clearances will be directly proportional to the length of engagement of the splines. Thus, length of engagement should be kept to the minimum that is adequate to carry the load.

In the examples summarized in Table 2, a length of engagement equal to the pitch diameter of the involute splines has been assumed. If this length were reduced to one-quarter of this diameter, for example, the amount of the clearances for any given misalignment angle (for the same diameter and number of splines) would be reduced to one-quarter of the tabulated values.

Fig. 3 shows one method of restricting the length of engagement of a splined member which has axial freedom on a splined shaft. The diameters of the counterbores should be predetermined to restrict the misalignment angle to some maximum value.

For a perfectly aligned 2-in. pitch diameter, 30-deg. involute spline with a length of engagement equal to 0·500 in. (one quarter of the pitch diameter), the safe maximum transmitted load would be equal to or slightly greater than the safe torsional load on the splined shaft.

ESTIMATED LOAD CAPACITY OF MISALIGNED SPLINES

With a misaligned splined shaft and coupling, the intial contact is made on the corners or edges of the two driving splines at opposite ends of the portion in engagement, at 180 deg. from each other. Under load, these edges are deformed elastically in the general form of a wedge, the thickness of which varies from a maximum at the position of the initial contact to a minimum along the face of the contacting surfaces.

As has been pointed out, if the amount of the initial deformation on the driving splines is greater than the amount of the clearance on any of the adjacent splines, these other splines will carry some part of the total load. The amount of the load carried will depend upon the amount of elastic deformation. In other words, the elastic deformation of the materials will serve as a spring scale to weigh the load.

In order to obtain some measure of the loads, some safe maximum load intensity, in lb. per sq. in.

of full contact, must be selected. This could be the load that would keep the bending stress at the root of the spline within the bending endurance limit of the material.

The next essential is to have some measure of the amount of elastic deformation which would result from the applied unit load insensity. Safe maximum intensity of the applied load is imposed only at the edges of the two driving splines; everywhere else the intensity, and deformation, will be less. The maximum thickness of the deformation wedges of the two driving splines, therefore, is equal to the amount of elastic deformation set up by the maximum unit load intensity acting at the edges of the splines. On adjacent splines, the maximum thickness of the deformation wedge is equal to the difference between the maximum deformation on the driving splines and the amount of clearance on the adjacent splines. No load will be carried on any splines where the amount of clearance is greater than the maximum deformation on the driving splines.

The minimum thickness of the deformation wedge will depend upon the angle of the wedge and the length of contact. This minimum thickness will be zero when the length of the deformation wedge is less than F, the nominal length of contact of the splines. When the calculated length of contact is greater than the nominal length of contact, the minimum thickness of the wedge will be equal to the extra length of contact multiplied by the tangent of the angle of the wedge.

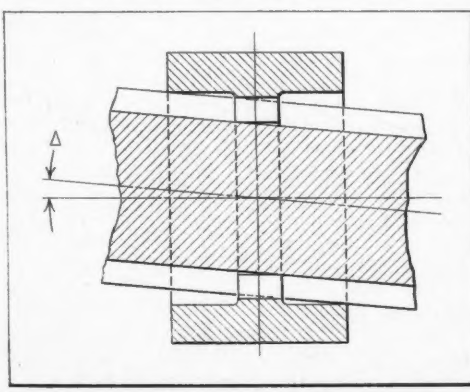


Fig. 3. Method of restricting length of spline engagement by counterboring the female member

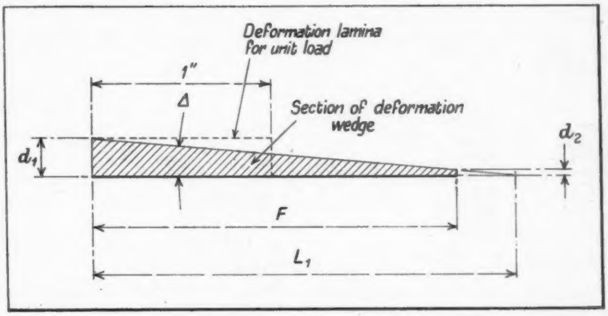


Fig. 4. Deformation wedge on a spline resulting from loading under conditions of angular misalignment

The actual angle of the deformation wedge will be somewhere between the misalignment angle and zero. For the sake of simplicity, it will be assumed to have a constant value which is equal to the misalignment angle Δ, as shown in Fig. 4. (Note: The actual angle of the deformation wedge on each spline varies between 0 deg. and Δ, depending upon the angular position θ of the spline, and may be calculated from the relation $\tan \beta = \tan \Delta \cos \theta$, in which β is the actual wedge angle at position θ.)

LIMITING UNIT LOAD VALUES

To begin the analysis, a limiting stress S for reversed bending of 40,000 lb. per sq. in. (for steel of about 225 Brinell) will be used with the Lewis form factors Y for ½ pitch splines to obtain a unit load value W in lb. per in. of face per spline. Harder and stronger materials will have other limiting stress values. From the Lewis formula,

$$W = SY/P, \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

are obtained the values for ½-pitch, 30-deg. involute splines given in the second horizontal line of Table 3.

The Lewis form factors Y used in computing these values were obtained graphically and are given in the third horizontal line of the table.

For 2-in. diameter splines of other pitches (fourth line in Table 3) the values for W (fifth line in the table) were obtained by dividing the foregoing values by the diametral pitch.

ELASTIC DEFORMATION UNDER LOAD

For the standard 30-deg. involute splines with an approximately uniform load from tip to root, the load per inch of face required to deform a spline

TABLE 3. UNIT LOAD VALUES FOR VARIOUS NUMBERS OF SPLINES AND PITCHES, ALSO MAXIMUM DEFORMATIONS FOR 2-IN. PITCH DIAMETER SPLINES

N =	8	12	16	20	24	32	40
W/in. =	28,525	30,662	32,672	33,803	34,683	35,688	36,442
Y =	0·713	0·767	0·817	0·845	0·867	0·892	0·911
P =	4/8	6/12	8/16	10/20	12/24	16/32	20/40
W/in. =	7,132	5,110	4,084	3,380	2,890	2,230	1,822
d =	0·001784	0·001277	0·001021	0·000845	0·000722	0·000557	0·000455

These values also represent the maximum thicknesses *d*, of the deformation wedges on the driving teeth of misaligned splines

by an amount of 0·001 in. would be about 4,000 lb. on a perfectly aligned spline. The value of the maximum deformation would therefore be equal to the applied load per in. divided by 4,000. Values for the maximum deformations of the various 2-in. pitch diameter splines obtained in this manner are given in the last line in Table 3.

DEFORMATION WEDGES AND EQUIVALENT SPLINE LOADS

The amount of the load carried on each spline may be estimated on the assumption that this value will be proportional to the amount of elastic deformation. The area of the cross section of the deformation wedge is compared with the area of the rectangular deformation lamina that would result from the application of the unit load on the straight spline, if there were zero misalignment. Fig. 4 shows these conditions. When

Δ = misalignment angle;
F = length of engagement of splines, in.;
L_1 = length to point of zero thickness of deformation wedge, in.;
d_1 = maximum thickness of deformation wedge, in.;
d_2 = minimum thickness of deformation wedge, in.;
l_a = length of deformation wedge, in.;
a_1 = area of section of deformation wedge, sq. in.;
a_2 = area of section of rectangular deformation lamina under unit load, sq. in.;
W = unit load per in. of engagement with zero misalignment, lb.;
W_N = load carried on deformation wedge, lb.;
W^1 = total load carried on all contacting splines, lb.;
d = thickness of rectangular deformation lamina under unit load in. (also equal to d_1 of driving tooth No. 0),

then, for any spline in contact:

$$L_1 = d_1 \cot \Delta \quad \text{.......................... (6)}$$

When L_1 is greater than F, the value of L_a is equal to F, and the value of d_2 equals $(L_1 - F) \tan \Delta$. When L_1 is less than F, the value of L_a is equal to L_1, and the value of d_2 is equal to zero.

$$a_2 = d \times 1{\cdot}000 = d_1 \times 1{\cdot}000 \quad \text{...... (7)}$$

$$a_1 = (d_1 + d_2)/2 \; L_a \quad \text{............ (8)}$$

$$W_N = (a_1/a_2)\, W \quad \text{.............................. (9)}$$

The driving splines at either end of the portion in engagement are numbered 0. The adjacent splines are numbered 1, 2, 3, etc. Whenever the clearances are less than the value of d_1, some load will be carried on those splines. Whenever the value of the clearance is greater than the value of d_1, no load will be carried on such splines.

The total load carried, W^1, will be the sum of twice the load carried on spline No. 0, twice the load carried on spline No. N/2, and four times the loads carried on all other spline numbers.

EXAMPLE OF LOAD CALCULATIONS

The eight-splined member of 4/8 pitch, 30-deg. involute form, with a length of engagement of 2 in., the clearances of which for various misalignment angles are given in Table 2, will be used for this example. The misalignment angle will be 0·05 deg., and the equations are solved in Table 3.

The total load for this misaligned spline, calculated in Table 3, is 40,440 lb. This load is only slightly more than one-third of 114,112 lb., the load which can be carried on the same spline when the alignment is perfect. In both these cases, the maximum root stress is the same.

A study of the values of W_N in Table 4 gives a picture of the load conditions on a given pair of mating splines as they rotate under load. At the position of spline No. 4, there is no load in the pair of splines. The load begins to build up just before the position of spline No. 3, and increases more and more until it reaches the maximum value at the position of spline No. 0, then falls to zero again as it passes the position of spline No. 3.

The values for the total loads for misalignment angles up to 0·500 deg., for this 8-splined member —also those for members with other numbers of splines—have been calculated in the same manner and entered in Table 5 for comparison.

The loads tabulated are based upon the limiting bending stresses at the roots of the splines. The shaft under the splines, however, also has a limit-

ing torsional stress condition that should not be exceeded.

For the particular steel used in this example, the limiting torsional load should not exceed about 25,000-in.-lb. torque. This value corresponds to a 25,000-lb. load applied at the 1·000-in. pitch radius of the splines.

TABLE 5. LOADS ON MISALIGNED SPLINES; 2-IN. ENGAGEMENT; 225 BRINELL STEEL

Δ (deg.)	0	0·05	0·10	0·15	0·20	0·25	0·50
8-T, 4/8 pitch ...	114,112	40,440	13,820	7,340	4,480	3,100	1,456
16-T, 8/16 pitch ...	130,688	19,250	6,700	3,560	2,360	1,720	544
32-T, 16/32 pitch ...	142,720	8,780	3,080	1,670	1,080	755	272

Limiting torque load at pitch line = 25,000 lb.

Table 5 affords an interesting indication of the influence of the number of splines and of the effect of increasing angles of misalignment. With misalignment, an increase in the number of splines results in a lower safe load capacity. If the loads are increased appreciably beyond the tabulated values, fatigue failure at the ends of the contacting splines is to be expected.

FLUCTUATIONS IN ANGULAR VELOCITY

It appears that the best practice to follow would be to use as small a number of splines as other conditions permit. There is some minimum number that must be used, however, to retain adequate smoothness of rotation. For example, if the number of splines could be reduced to two, then the operation would be practically the same as that of a single universal joint, with a varying rate of rotation for the driven shaft. The amount of this variation increases with an increase in the angle of misalignment. With eight splines as a minimum, however, the amount of variation in rotation would be reduced to much less than one-quarter of that for the single universal joint, and even with maximum angles of misalignment of 2 or 3 deg. the amount of rotational variation should not be noticeable on power drives.

TABLE 4. CALCULATION OF LOADS ON THE SPLINES OF AN 8-SPLINE 4/8 PITCH MEMBER, OF 225 BRINELL STEEL AND WITH 0·05-DEG. MISALIGNMENT ANGLE

$R_1 = 1{\cdot}0$ in.; $F = 2{\cdot}0$ in.; $\tan \Delta = 0{\cdot}00087$; $\cot \Delta = 1{,}145{\cdot}9153$;
$W = 7{,}132$ lb./in.; $a_2 = 0{\cdot}001784$ for 7,132 lb./in.

Tooth number $N =$	0	1	2	3	4
$C_1 =$	0	0·000295	0·001008	0·001720	0·002015
$d_1 = 0{\cdot}001784 - C_1 =$	0·001784	0·001489	0·000776	0·000064	No load
$L_1 = d_1 \cot \Delta \ldots =$	2·044313	1·706268	0·889230	0·073339	—
$La =$	2·000000	1·706268	0·889230	0·073339	—
$d_2 = (L_1 - F) \tan \Delta =$	0·000038	0	0	0	—
$a_1 = La(d_1 + d_2)/2 =$	0·000911	0·000745	0·000338	0·000032	—
$a_1/a_2 = a_1/0{\cdot}001784 =$	1·021300	0·712444	0·193385	0·001122	—
$W_N = 7{,}132\,(a_1/a_2) =$	7,284	5,081	1,379	8	0

W^1 = total load $= 2W_O + 4W_1 + 4W_2 + 4W_3 + 2W_4$
$= 14{,}568 + 20{,}324 + 5{,}561 + 32 + 0 = 40{,}440$ lb.
Total load when $\Delta = 0$ deg. is $8 \times 2 \times 7{,}132 = 114{,}112$ lb.
Limiting torque load at pitch line = 25,000 lb.

EFFECT OF SHORTER LENGTH OF SPLINE CAPACITY

To complete this analysis of misalignment of straight splines, the load capacities of the same splines but with the lengths of engagement reduced to 0·500 in. were calculated. The clearances shown in Table 2 for 2-in. lengths were therefore reduced to one-quarter of the tabulated values, as indicated by Formula (1), since F had been reduced by three-quarters. The unit load and deformation values remain unchanged.

The loads for the shorter lengths of spline were calculated in the same manner as before. It should be noted, however, that with the shorter lengths, the deformations from the loads on opposite ends of the spline may overlap and increase the root stresses unless the unit load value is reduced. For example, on the 8-splined member, splines No. 0 and 4 are loaded concurrently from the contact on opposite ends, when the clearance is small enough to permit contact on spline No. 4. In like manner, splines No. 1 and 3 are loaded simultaneously from both ends. Also, spline No. 2 is in the same condition.

The load calculation is started as before, and carried through until the value of d_2 on spline No. N/2 is determined. If the length of the deformation wedge L_1 is greater than the length of engagement of the splines, then the unit load deformation on the loaded edge of spline No. 0 must be reduced by one-half of the value of d_2 on spline No. N/2. The calculations of the loads on the splines of the 8-splined member with a length of engagement of 0·500 in. are shown at the top of Table 6. The full length of the deformation wedge of spline No. 0 is 2·044313 in. so that the deformation wedges of the splines numbered

0 and 4 overlap. The thickness of the small end of the wedge of spline No. 4, d_2, is 0·000841 in. This condition will overload the spline. The maximum value of 0·001784 in. must be reduced by 0·000841/2 or 0·000421 in. Thus, the unit load value on spline No. 0 must be reduced to one that developes a unit deformation of (0·001784-0·000421), or 0·001363 in. Since it requires a unit load of 4,000 lb. to produce an elastic deformation of 0·001 in., the new maximum unit load is 1·363 × 4,000, or 5,452 lb. per in. The load calculation is then carried through as before with the revised unit load and deformation values, as indicated in Table 6.

The loads for all the 0·500-in. face splines have been calculated for misalignment angles up to 0·500 deg. These values too are listed in Table 6.

A comparison of Tables 5 and 6 should be of interest. Except for the case of zero misalignment, the safe loads are generally larger for the 0·500-in. length splines than for the longer length of engagement, and the relative position improves as the angle of misalignment increases. It would appear that the engagement of straight splines should be kept as short as other conditions permit. In any case, the safe load to use is either the limiting torque load of the shaft or the spline load for the maximum misalignment that is permitted—whichever is the smaller.

The second and concluding part of this article will be published in a forthcoming issue of MACHINERY.

TABLE 6. LOADS ON 8-, 16-, AND 32-SPLINED MEMBERS OF 225 BRINELL STEEL FOR 0·50-IN. ENGAGEMENT

R_1 = 1·0 in.; W = 7,132 lb./in.; F = 0·5 in.; A_1 = 0·001784 in.
Δ = 0·05 deg.; tan Δ = 0·00087; cot Δ = 1,145·9153
Limiting Torsion Load at R_1 = 25,000 lb.

Sample Calculations for 8-splined members

Tooth number =	0	1	2	3	4
C_1 =	0	0·000074	0·000252	0·000430	0·000504
$d_1 = 0·001784-C_1$ =	0·001784	0·001710	0·001532	0·001354	0·001280
$L_1 = d_1 \cot \Delta$ =	2·044313	1·959515	1·755542	1·551569	1·466772
L_1-F =	1·544313	1·459515	1·255542	1·051569	0·966772
$d_2 = (L_1-F) \tan \Delta$ =	0·001344	0·001270	0·001092	0·000915	0·000841

Since spline No. 4 is the driving spline at the other end of the spline engagement and has 0·001784-in. deformation there, the total deformation is 0·001784 + 0·000841 = 0·002625 in., which exceeds the limiting deformation permitted by the maximum allowable stress. The deformation must therefore be reduced by 0·000841/2 at both ends. Thus, corrected unit deformation = 0·001784–0·000421 = 0·001363 and the equivalent unit load = 1·363 × 4,000 = 5,452 lb. The recalculation of the above data is as follows:—

$d_1 = 0·001363-C_1$ =	0·001363	0·001289	0·001111	0·000933	0·000859
$L_1 = d_1 \cot \Delta$ =	1·561883	1·477085	1·273112	1·069139	0·984341
L_1-F =	1·061883	0·977085	0·773112	0·569139	0·484341
$d_2 = (L_1-F) \tan \Delta$ =	0·000924	0·000850	0·000672	0·000495	0·000421
La =	0·500	0·500	0·500	0·500	0·500
$(d_1+d_2)/2$ =	0·001144	0·001070	0·000892	0·000714	0·000640
$a_1 = La(d_1+d_2)/2$ =	0·000572	0·000535	0·000446	0·000357	0·000320
$a_1/a_2 = a_1/0·001363$ =	0·419662	0·392516	0·327219	0·261922	0·234776
$W_N = 5,452\,(a_1/a_2)$ =	2,288	2,138	1,783	1,427	1,279

$$W^1 = \text{total load} = 2W_O + 4W_1 + 4W_2 + 4W_3 + 2W_4$$
$$= 4,576 + 8,552 + 7,132 + 5,708 + 2,558 = 28,526 \text{ lb.}$$

Comparison of Calculated Loads for 8-, 16-, and 32-splined members

Δ (deg.)	0	0·05	0·10	0·15	0·20	0·25	0·50
Spline	Limiting Total Loads, W^1, lb.						
8T, 4/8 P	28,526	28,526	27,024	15,498	10,127	7,092	2,564
16T, 8/16 P ...	32,672	32,670	13,574	7,306	5,048	3,424	1,184
32T, 16/32 P ...	35,680	17,975	55,274	3,219	2,073	1,541	520

Enots Heavy-duty Air Cylinder

A new range of 4½- and 6-in. bore, double-acting, heavy-duty air cylinders has been introduced by Benton & Stone, Ltd., Aston Brook Street, Birmingham, 6. These cylinders have duralumin barrels and end covers, which are held by tie bolts, and can be supplied in cushioned and non-cushioned types. The latter are available in a range of standard stroke lengths from 1 to 12 in., but the minimum stroke length for the cushioned cylinders is 3 in. Both types can be supplied with strokes up to 7 ft., to order.

The maximum working pressure is 150 lb. per sq. in., and each cylinder has two ½-in. diameter pipe connections at each end. A ground, stainless-steel piston rod is employed, which has a 1-in. B.S.F. thread and slides in an oil-impregnated bush in the end cover. Cylinders can be arranged for foot or screw mounting at both ends, front or rear flange mounting, rear trunnion mounting, and —in the case of the 4½-in. size—screw mounting at the front end only.

Eastern Bloc Machine Tools

A Survey of Recent Price Levels

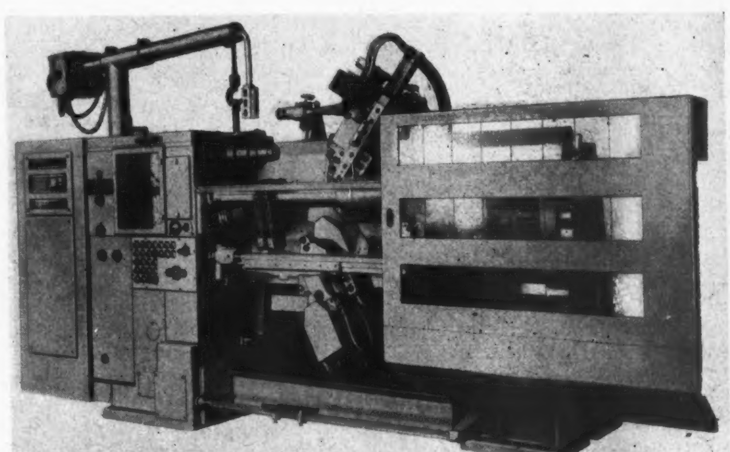
By a Correspondent

THE MAJOR PORTION of the machine tool exports from the Eastern Bloc has in the past been consigned to countries of a similar political pattern, but it is evident from the increased advertising propaganda and participation in both British and Continental exhibitions that considerable efforts are now being made to penetrate Western markets for prestige and other reasons. The Soviet authorities, in particular, have displayed a lively interest during the past two years in British importing firms and their capabilities for handling imported machines both as regards sales and after-sale service.

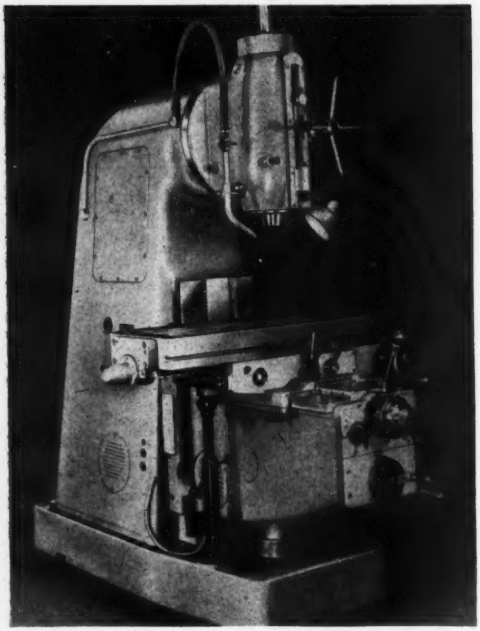
Although, as a result of inspection at exhibitions and discussions of the limits to which the machines are built, the majority of machine tool engineers and potential users are beginning to have informed opinions of the quality of these products, it is not unfair to say that the main appeal, so far, has been low first cost. In Western Germany, the country which is the largest importer of machines of Eastern origin, the machine tool builders' association recently referred to offers of certain machines at approximately half the generally accepted price levels. In this connection, it is of course well-known that with any state-controlled economy, export prices do not necessarily bear any relation to cost of production, and export delivery times need not be hampered by keen domestic demand. If sterling, marks, lire, or other currency is needed, export products are offered at such prices as will quickly secure the amount of that currency required. It is of interest, therefore, to draw attention to what is happening in certain typical industrial countries in Western Europe.

Communist statistics furnish little or no information of value to the enquirer beyond the number of units delivered and the number of types produced, but fortunately the import figures of most of the receiving countries are more informative, since they normally indicate not only the number of machines imported but also the weights and values. From such sources of information, therefore, it is possible to form some opinion as to the general price levels at which machines are being and are likely to be offered, and the extent to which a given market is likely to be penetrated in this manner. An examination of average prices per ton enables a reasonable assessment of price levels to be made in comparison with those of machines from the other main producing countries, by someone with adequate knowledge of the industry and of export markets. Convenient yardsticks are afforded by the average export prices of machine tools in 1960 from such countries as the United Kingdom (£714 per ton); West Germany (£738 per ton); and France (£792 per ton).

U.S.S.R.—Stankoimport, Smolenskaja - Sennaja 32/34, Moscow G 200—exports and imports.



Czechoslovak semi-automatic copying lathe with programme control



Hungarian type VF 22 vertical milling machine made by Rakoli (formerly Manfrid Weiss) Works

Contrary to general belief, this country, in spite of the immense development of the machine tool industry, is not the one which has made the greatest impact on Western countries. During 1960, which is the year under review, only two lathes and a milling machine were imported into the United Kingdom, although the Board of Trade had agreed to grant licences to the value of £500,000 in that year. The following table shows the position for the principal importing countries:

	Tons	Value (£)	Ton-value (£)
United Kingdom ...	3·9	3,560	901
West Germany ...	382	187,074	490
France	27	15,796	585
Switzerland ...	—	—	—
Italy	144	61,600	428
Austria	314	135,278	431

Czechoslovakia.—Strojexport, Václavské nàm, Praha 2. The machine tool industry of this country has had a longer tradition than that of any other communist countries, and has been the most successful in developing export trade with the West. German imports, for instance, have more than doubled since 1958.

	Tons	Value (£)	Ton-value (£)
United Kingdom ...	546	272,973	499
West Germany ...	3,053	1,144,217	374
France	161	79,787	496
Switzerland	218	86,660	397
Italy	960	489,771	510
Austria	950	384,861	405

Hungary.—Technoimpex, Dorottya-u. 6, Budapest 62. The machine tool trade of this country has only been developed recently, and nothing has been exported to the United Kingdom since 1958, when eight machines came in, with a ton-value of £437. In other markets last year the Hungarian industry was more successful, mainly with radial drilling machines. It should be noted, however, that machine tool production is now no longer confined to the simpler types as it was some years ago, and includes, for instance, electro-erosion machining equipment, electronic balancing machines, and centreless grinders.

	Tons	Value (£)	Ton-value (£)
United Kingdom ...	—	—	—
West Germany ...	376	184,863	491
France	110	43,349	394
Switzerland	59	30,166	511
Italy	524	201,029	384
Austria	210	97,819	466

Poland.—Metalexport, 49 Mokotowska, Warszawa. During 1960 the United Kingdom imported 22 machines, business with that country having shown a steady growth during the past three years. It is noticeable, however, that Polish press publicity on the subject of the numbers and types of machines ordered from this country is not invariably followed by confirming evidence in British customs returns for the succeeding years.

	Tons	Value (£)	Ton-value (£)
United Kingdom ...	122	50,958	417
West Germany ...	159	77,976	490
France	26	10,290	396
Switzerland	44	20,833	473
Italy	287	130,286	454
Austria	134	64,806	484

East Germany.—Deutsche Export- und Importgesellschaft, Schicklerstrasse 7, Berlin C2, G.D.R. In this country, also, the machine tool industry is being intensively fostered and the following table shows the volume of exports to the West, apart

from trade with the Federal Republic, for which exact figures are difficult to obtain.

	Tons	Value (£)	Ton-value (£)
United Kingdom ...	299	158,647	530
France	159	106,650	670
Switzerland	80	24,250	303
Italy	155	79,029	513
Austria	870	323,152	371

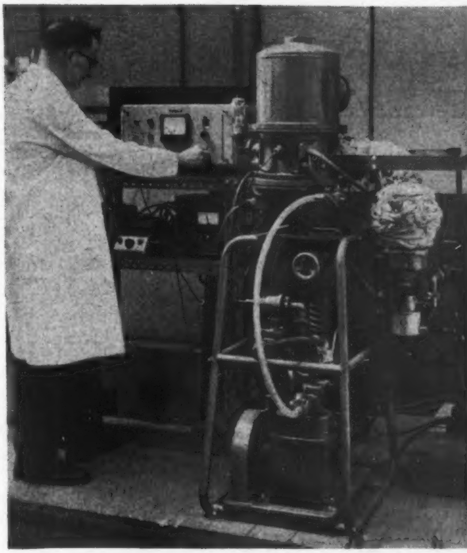
Figures such as those quoted will help to correct many of the conclusions and opinions which are voiced in the popular press. For their proper interpretation, however, they require a certain acquaintance with the industry, with the producing countries, and with export markets, if mere comparison of ton-values is not to lead to false conclusions. Whereas a layman, on finding that Belgian machine tool ton-values averaged £557, and Swiss ton-values, £1,553, might conclude that the Swiss industry was doomed to early extinction on account of competition, the machine tool engineer is not likely to make any such erroneous assumption.

It also is as well to bear in mind an observation made by the German machine tool builders' association in connection with the Melman recommendations that machine tools should be cheapened by mass-production methods. It was suggested that communist experience with low prices had shown that this policy did not increase the market to any considerable extent, and this opinion certainly seems to be borne out by the figures given here for 1960.

Leybold-Elliott Ultra-high Vacuum Coating Plant

Intended to provide for the deposition of thin, high-purity metallic films, the UPO4 prototype ultra-high vacuum coating plant, here shown, has been developed in Germany, and to ensure a low rate of leakage, the working chamber is surrounded by a second chamber, which is evacuated by a conventional pump set to an ultimate pressure of approximately 10^{-5} Torr. The working chamber is evacuated by a fractional oil diffusion pump, which is backed by another diffusion pump and a 2-stage gas ballast rotary vane pump, and with this arrangement, a pressure of 10^{-9} Torr is obtained in 4 to 5 hours.

A Meisener-type liquid air trap is provided inside the working chamber, the casing of which is made from stainless steel and has copper gaskets for sealing the joints where units are mounted for conducting electrical supplies through the wall. Advantage is taken of the electrical resistance of the casing to provide for heating up to 400 to 450 deg. C., for out-gassing. The casing of the outer chamber is of mild steel, and synthetic rubber gaskets are employed. Designated UPO5 and UPO6, standard units of designs based on this plant can be supplied by Leybold-Elliott, Ltd., Manor Way, Borehamwood, Herts., a member-company of the Elliott Automation Group.



Leybold-Elliott UPO4 prototype ultra-high vacuum coating plant

ELECTRO-MAGNETIC PLATE HANDLING EQUIPMENT.—Melbro Magnetic Tools, Ltd., 2a Alexandra Road, Manchester, 15, have introduced a range of beams for lifting steel plates in horizontal and nearly vertical positions. These beams are provided with small electro-magnets which can be arranged in various plan patterns for lifting plates of different dimensions with weights up to 20 tons. Individual magnets with capacities of ½, 1, 2 and 3 tons are available. Each beam is arranged for rotation in the horizontal plane, and all functions can be controlled from the crane cab. Emergency batteries are provided in the feed circuit to the magnets and in the event of power failure the load can thus be sustained for periods up to 30 min. The equipment also includes a voltage regulator to permit lifting a single plate from a stack.

New Cross Trunnion-type Machines

TRUNNION-TYPE MACHINES in a new range introduced by the Cross Co., Detroit, Michigan, U.S.A., are intended for operations on components which may be of similar design but different sizes, and made from dissimilar metals.

For example, the 10-station machine shown in Fig. 1 is designed for performing operations such as rough, semi-finish, and finish boring, also facing, drilling, counterboring, chamfering, tapping and grooving, on "remote accessory" cylinders for tractors, which are made in two different lengths from nodular and grey iron. Boring, drilling and counterboring are carried out with spindles mounted on two main heads, and there is a total of four auxiliary heads for the remaining operations. The tapping heads, one of which may be seen in the close-up view, Fig. 2, are advanced to the cutting positions by the main heads, but they incorporate separate motors for driving the leadscrew-controlled tapping spindles. The spindles for the facing heads are driven from the main cutter heads, and are positioned by large-diameter guide bars carried on trunnion-type support members. With this arrangement, there is only a small overhang between the generating-type facing tools and the support members. Facing is carried out on both ends of the cylinders during the working cycle.

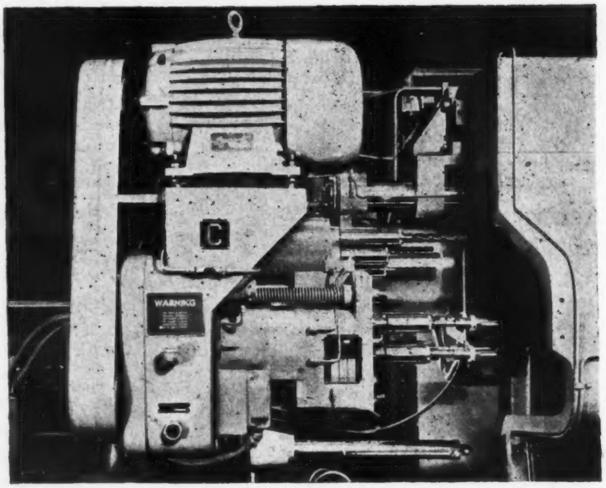


Fig. 2. Close-up view of one of the tapping heads on the Cross machine shown in Fig. 1

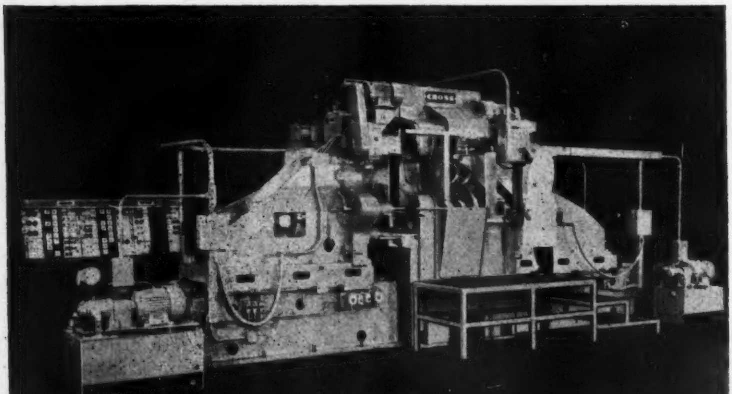


Fig. 1. This Cross 10-station trunnion-type machine is intended for handling nodular and grey iron cylinders of two different lengths

The main bore in the cylinder is held within $+0.000 / -0.002$ in., and the bore for the piston rod within ± 0.001 in. for diameter, and within 0·003 in. total indicator reading, for concentricity. One end face is held within 0·001 in. for squareness with the main bore. For changing the set-up for handling cylinders of a different length, it is only necessary to change some of the cutting tools and component parts for the work-holding fixtures, also to adjust the dogs for controlling the

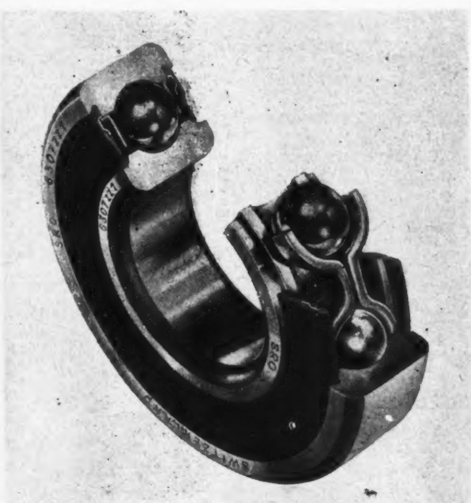
traverse movements of the cutter heads. Spindle speeds and feeds can be varied to suit different work materials. It is stated that a change of set-up can be completed in about 30 min.

The makers are represented in Europe by Cross International A.G., Fribourg, Switzerland.

New SRO Sealed Ball Bearings

Deep-groove ball bearings in a range introduced recently by SRO Ball Bearing Works, J. Schmidt-Roost, Ltd., Zurich-Oerlikon, Switzerland, who are represented in this country by SRO Bearing Co. (Sales), Ltd., 164 Camberwell Road, London, S.E.5, incorporate synthetic rubber sealing rings, which are secured to the outer races and rub against the surfaces of annular recesses in the inner races. It is stated that a high sealing efficiency is thus ensured, and each seal is stiffened by a formed metal ring, to prevent contact with the ball cage and thus avoid the need for limiting the maximum speed at which the unit can be operated.

A cut-away bearing is shown in the accompanying illustration, and the range includes certain sizes from the company's 6000, 6200, 6300 series, which are available with seals at both sides of the bearing. If required, bearings with seals at both sides can be supplied lubricated for life with a grease which is suitable for use at temperatures from −22 to 235 deg. F.



A cut-away view of a sealed ball bearing from the new SRO range

Application of a Cogsdill Bearingizing Tool for Finishing Helicopter Rotor Parts

At the works of the Vertol Division of the Boeing Airplane Co., U.S.A., a Bearingizing tool, supplied by Cogsdill Tool Products, Inc., Oak Park, Michigan, U.S.A., is employed for finishing the bores for the taper pins which hold the blades of helicopter rotors to the hubs. Holes in the mating components are required to have a surface finish of 16 micro-inches or better, and must be held to a tolerance of 0·0004 in. for diameter, and 0·0003 in. for taper.

Application of a Cogsdill Bearingizing tool for finishing taper holes in helicopter rotor parts to a finish of 16 micro-inch or better

These parts were previously finished by reaming or grinding, but it has been found that the required surface quality and accuracy can be rapidly obtained by means of the Bearingizing tool. The latter, which may be seen in the accompanying illustration, is mounted on a spindle and rotated at about 400 r.p.m. It incorporates a number of hardened and ground steel rollers which are contained in a cage surrounding the body. Cam faces on the body engage the rollers as the tool rotates, and the work is thus subjected to rapid radial blows. It is stated that

a surface finish of 3 micro-inches can be obtained.

The sole agents in this country for Cogsdill Bearingizing tools are Henry Challis, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11.

Lockheed Hydraulic Unit for Positioning Aircraft Jig Components

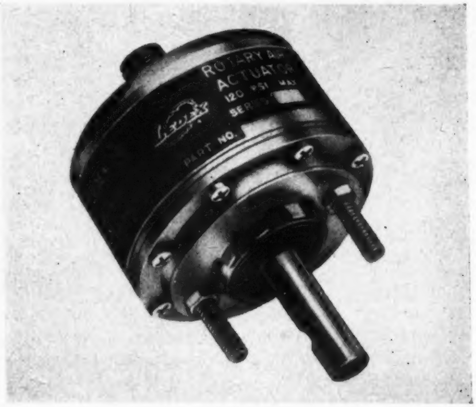
To facilitate setting up the component parts of large jigs employed in aircraft construction, the Lockheed Aircraft Co., U.S.A., have developed the portable hydraulic positioner shown in the accompanying illustration. It incorporates six hydraulic cylinders which provide for linear and rotary movements in vertical and horizontal planes, and jig components weighing up to 2,000 lb. can be handled.

The jig component is held by temporary clamps in approximately the required location and it is next engaged by the positioner unit. The latter, in conjunction with optical tooling telescopes, is then employed to position the component precisely. A strong cement, comprising a mixture of Kerrstone and water, which hardens in 8 to 15 min., is applied to hold the jig component permanently in position. Four of these positioning units have been built, and it is stated that they have enabled jig setting-up time to be reduced by 80 per cent. They are being marketed by the Special Products Sales Unit of the California Division of the company.

Lockheed hydraulic positioner for aircraft jig components. An enlarged view of the control box is shown inset

Ledex Series 50 Air-operated Rotary Actuator

The series 50 air-operated miniature rotary actuator shown in the figure has been introduced recently by N.S.F., Ltd., 31-32 Alfred Place,



Ledex series 50 air-operated miniature rotary actuator

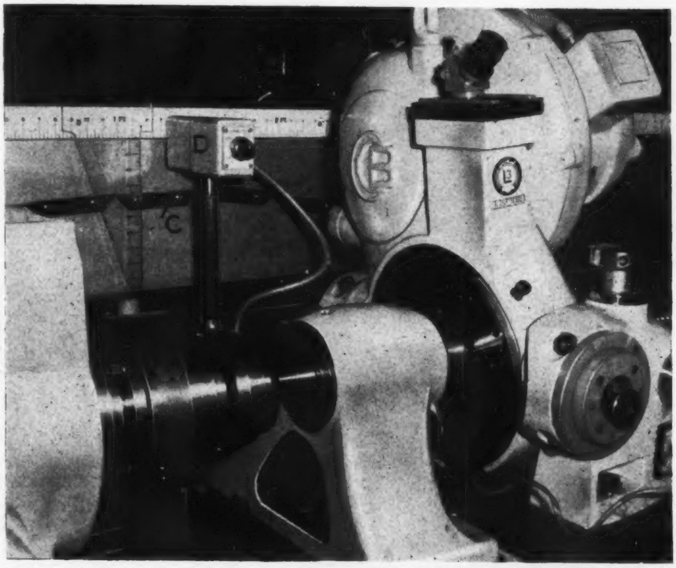
London, W.C.1, who are the British licensees for Ledex, Inc., U.S.A. When compressed air is supplied at the maximum working pressure of 120 lb. per sq. in., a torque of 6·5 lb.-in. is obtained at the output shaft, which can be turned through a maximum angle of 90 deg. It is the first of a range of units, to provide torques from 1·35 to 94 lb.-in.

Weighing approximately 8 oz., the unit incorporates a 0·78-in. stroke piston, movement being transmitted through a system of balls in inclined races to the output shaft, which can be coupled directly to the load. A rapid response is obtained, due to the short displacement, and torque is uniform throughout the full movement.

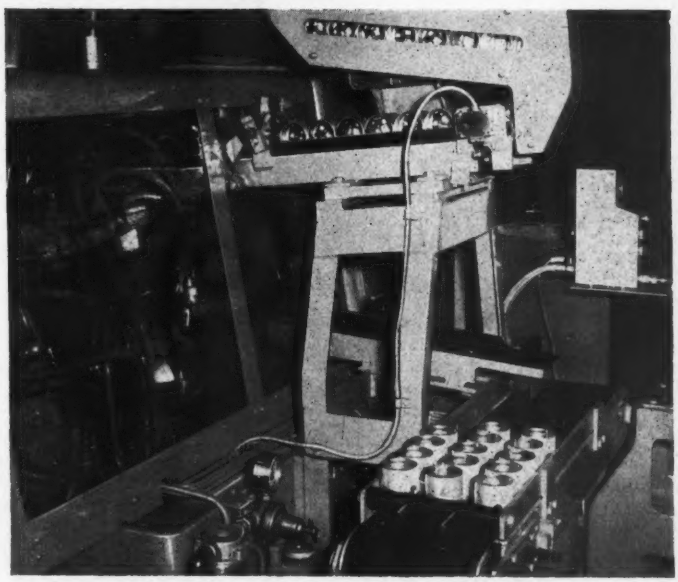
All the working parts are enclosed, and are self-lubricating, and shaft seals are not employed. Applications for which the unit is intended include the operation of clamps, indexing equipment, and gates on conveyors.

Seen at Brussels

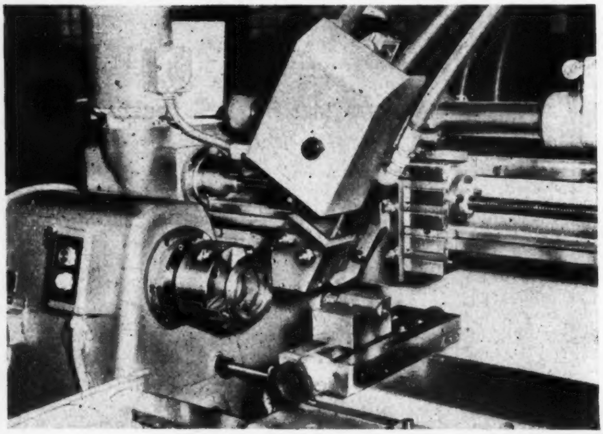
Some Close-up Views of Exhibits at the 7th European Machine Tool Exhibition



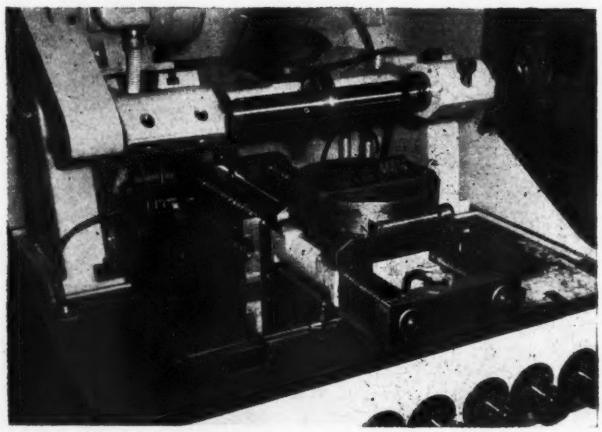
On the latest Whirlmatic thread whirling lathe (B.P.S. Machinery & Spares, Ltd.), a cam which provides for corrections for pitch errors in the leadscrew, is built up from a number of metal strips as shown at *C*. These strips are held on a vertical plate at the rear of the bed by magnets, and are positioned with the aid of scales. During thread whirling, the switch unit *D*, mounted on the saddle, follows the cam and transmits signals to a motor at the tailstock end of the bed, which drives, through gearing, a threaded sleeve surrounding the leadscrew. Axial movement is thus imparted to the leadscrew to compensate for the pitch errors



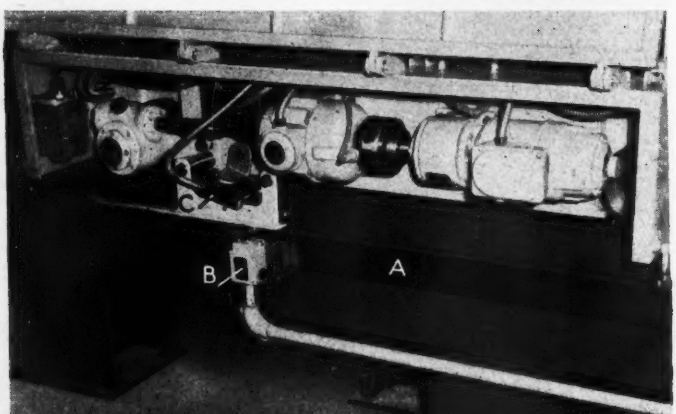
The automatic work-feeding and delivering equipment provided on a special piston skirt turning machine built by the Machine Tool Division of Renault, Billancourt, France [Renault Machine Tools (U.K.) Ltd.]. The pistons are fed to the machine by way of an escapement mechanism, and subsequently leave the working area by the inclined chute at the centre. As they leave the chute, they are turned through 90 deg., to fall, crown-first, on the belt conveyor in the foreground



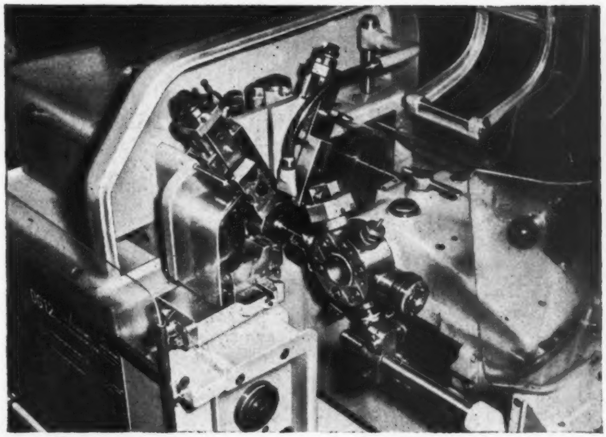
A new overhead copy-turning slide is here shown on a French-made Cri-Dan B threading machine [Cri-Dan (London), Ltd.]. At the set-up illustrated, a cut is taken on an internal chamfer and the 3⅜-in. bore of a flanged steel component during the first part of the movement of the copying slide towards the headstock. With continued movement, a cut is taken on the face and bevel portion of the flange by a separate tool. Copy turning completed, a thread is cut in the bore by a tool mounted on the saddle



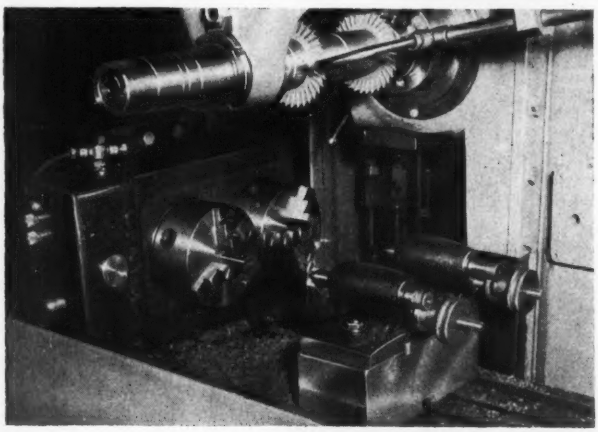
This set-up served to demonstrate the Meyer & Burger, Ltd., Switzerland, type TS 3 cutting-off machine for slicing germanium and silicon, also for sawing quartz, ruby, glass, tungsten carbide and ceramic materials. Driven by a 1·1-h.p. motor, the diamond-impregnated slitting disc can be rotated at 6,500 or 4,500 r.p.m. The rotary work-table is provided with micrometer adjustment, for angular position, and can be tilted about a horizontal axis



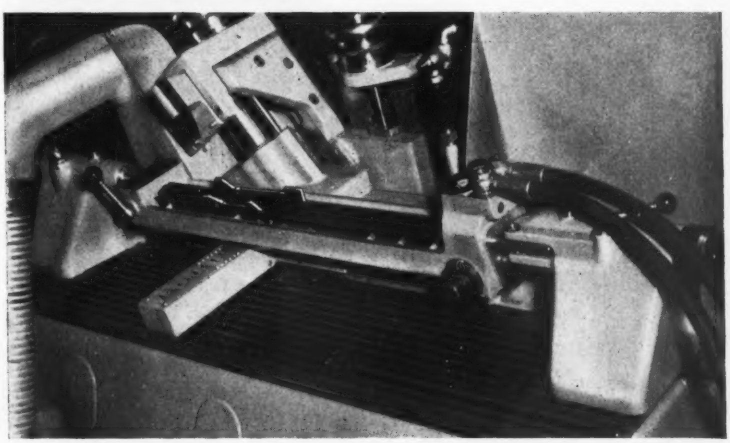
On the French-built Ehl-Latic fully-automatic metal cold-sawing machine (J.V. Morand, Ltd.) the gauging carriage, which acts as an end stop and determines the length of stock to be cut off, is power driven. A Bar *A* on the front of the bed incorporates switches, as at *B*, which are cam-actuated to change rapid traverse of the carriage to creep speed. The carriage is stopped when a blade behind the switch intercepts a photo-electric cell system *C*



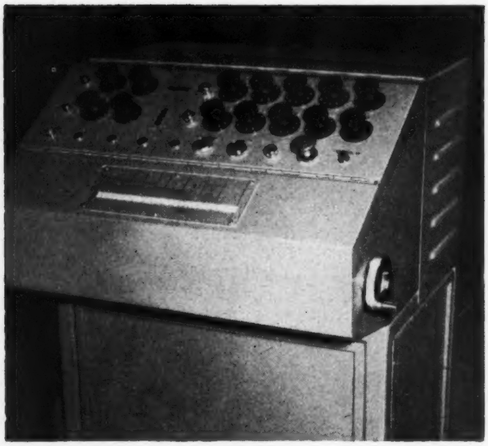
At this set-up for producing a 1-in. long nipple component from $\frac{7}{16}$-in. diameter brass bar in a cycle time of 11 sec. on the new Index type DG 12 automatic [George Kingsbury (Machine Tools), Ltd.], a high-speed attachment is mounted on the turret for deep-hole drilling a $\frac{1}{8}$-in. diameter central hole, also a reciprocating cutter head for milling a cross slot in the end of the workpiece. A spindle speed of 5,180 r.p.m. is employed for turning, 1,680 r.p.m. for cutting a $\frac{5}{16}$-in. diameter external thread, and 670 r.p.m. for tapping the central hole for part of its depth



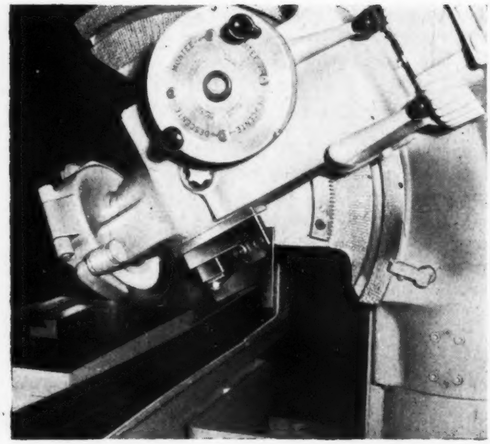
The new Centec air-operated indexing unit can be supplied with one or more "slave" spindles, to enable multiple workpieces to be held. Slave units are driven from the main spindle unit by gearing, and centre distances down to 4 in. can be provided for multiple assemblies. Designed for mounting in a variety of positions, the unit has an overall thickness of only $3\frac{1}{2}$ in., and can be set for indexing through angles of 30, 60 and 90 deg. by means of two plunger-type air valves. The spindles can be fitted with 3-jaw chucks, as shown, or air-operated collets



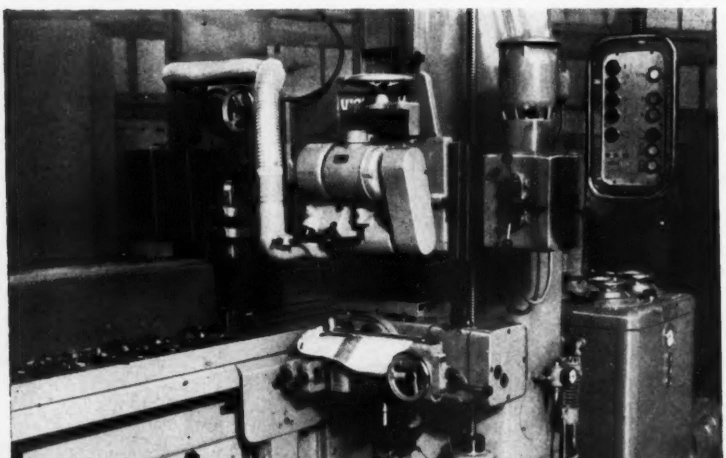
Close-up view of a prototype indexing template holder mounted at the rear of the bed on the Swiss-made Dubied 517 hydraulic copying lathe (Wickman, Ltd.). With the set-up illustrated separate templates for copy-turning different profiles at the opposite ends of a shaft component at separate operating cycles are mounted in the holder



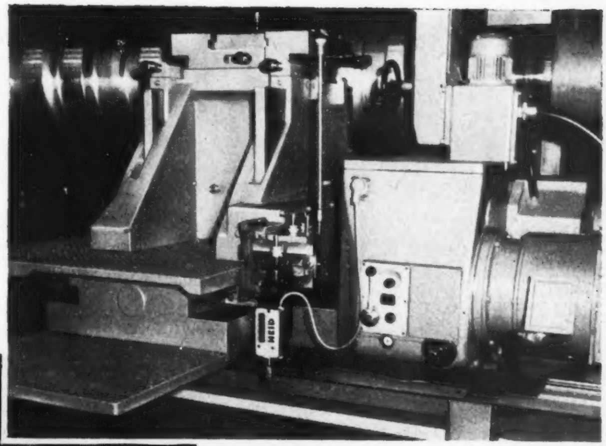
The control desk on the G.S.P. type 405 P.8 tape-controlled co-ordinate drilling and boring machine (Stanhope Machine Tools, Ltd.) incorporates dials for alternative hand-setting of dimensions in two axes. These settings are made by the operator in accordance with information on a paper chart, which can be unrolled past a narrow window by means of the handwheel at the right. The chart also provides data concerning tool number; spindle speed; feed rate; and vertical travel of the spindle



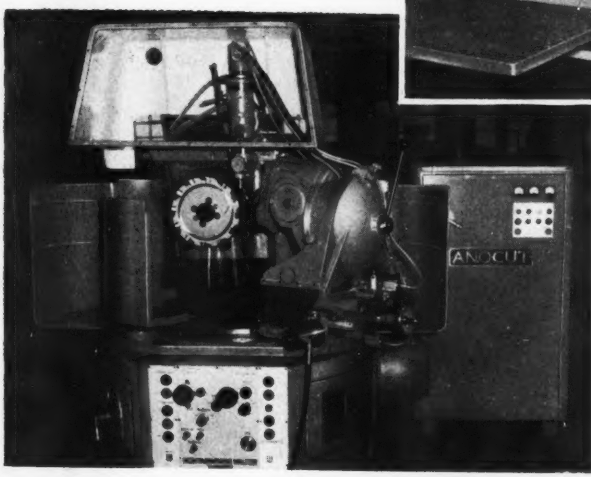
On the French-built Schneider Creusot type RUP 48 Y 4 surface grinder [Machine Tool Sales (London), Ltd.] the wheel-head can be set for angle with the aid of a sine bar attachment. The attachment is set by means of slip gauges, and the wheel-head is then tilted until an edge on the sine bar has been brought to the vertical position. A dial indicator is traversed for the length of the vertical edge on the sine bar for checking the setting of the wheel-head



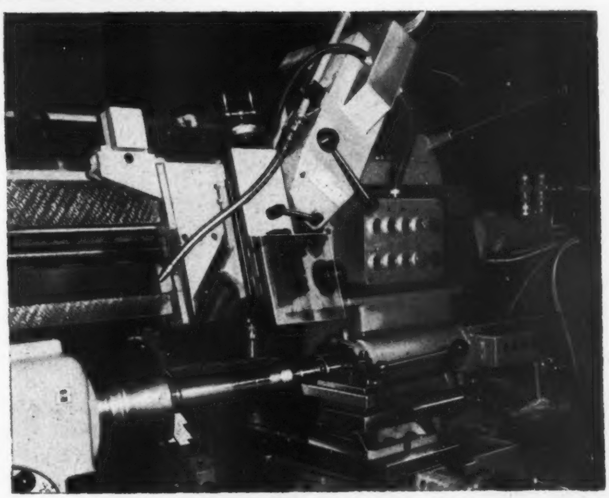
Close-up view of the Waldrich-Coburg open-side planing and grinding machine type 2 ES 1515 (Drummond Asquith, Ltd.) showing the grinding head which is incorporated. The planing tool-box can be traversed to the extreme left-hand end of the rail, and the grinding head moved into the working position. Complete slideway protection against the ingress of grinding dust is provided, also built-in extraction equipment



Heid electro-magnetic copying equipment is employed for controlling the saddle and cross-slide movements on the new Italian-built Eustacchio type TC.100 C roll turning lathe (Selson Machine Tool Co., Ltd.). Sliding and surfacing feeds are derived from a motor-driven gearbox on the saddle, and the template is mounted at the front of the bed

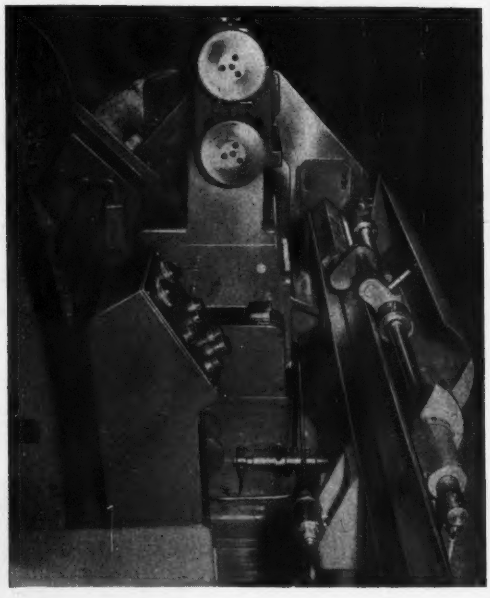


The type AMS 500 machine built by Montanwerke Walter A.G., Germany (Elgar Machine Tool Co., Ltd.) is here shown fitted with Anocut equipment for sharpening milling cutters by the electrolytic grinding process. The machine will handle cutters from $3\frac{1}{2}$ to 20 in. diameter, and enables corner radii and cutting edges at the face and periphery to be ground at a single automatic cycle, if required



The Goliath type G 2, $17\frac{5}{16}$-in. swing, heavy-duty centre lathe built by Eugen Weisser & Co., KG., Germany (Stanley Howard, Ltd.), is here shown fitted with a new overhead copy-turning slide. At this set-up, profile turning is carried out on a stepped-diameter shaft, and a single-point cutting tool mounted on the front of the cross-slide is then brought into use for screw-cutting with the high-speed mechanism built into the lathe

Set-up on a German Modler machine (Selson Machine Tool Co., Ltd.) for grinding barrel-shaped rollers for anti-friction bearings. Fed from the chute in the background, the rollers drop into carbide seatings in the rotating nest *A*, and are thus carried between the control and grinding wheels. The control wheel *B* is of part-spherical form and the grinding wheel is dressed to a concave profile. After each roller has passed the grinding wheel, a simple finger pushes it from its seating into a delivery chute



Close-up view of the automatic work-feeding unit on a Rowland type HDD/C double-disc surface grinder. The rectangular components are placed in a stack in a V-shaped trough, and are moved along continuously by a weight-operated pusher. They enter apertures in a rotating disc, which carries them between the grinding wheels. When a fresh batch of components is to be loaded, the pusher is returned to the starting position by an air cylinder

On the new French-built H.E.B. Transpilote copying lathe (Drummond-Asquith, Ltd.), fine adjustments for the depth of cut are made by swivelling a horizontal shaft which carries brackets for holding the cylindrical master. With the set-up here shown, a completed workpiece is loaded into the comparator *A* mounted at the right-hand end of the bed. If the work diameter is not within the specified limits, an error signal from the gauging equipment is passed to a small motor housed in the unit *B*, which causes the shaft to be swivelled by the amount required to provide the necessary correction

Production Facilities for British Clearing Presses and Vickers-McKay Equipment

In 1946 an arrangement was negotiated by the agents, Rockwell Machine Tool Co., Ltd., Welsh Harp, Edgware Road, London, N.W.2, for the production of presses to the designs of what is now the Clearing Division of U.S. Industries, Inc., at the works of Vickers-Armstrongs (Engineers), Ltd., Newcastle-upon-Tyne. From that time, up to the end of August last, a total of 1,556 British Clearing presses and press brakes had been delivered, ranging from 30-ton welding presses to 1,950-ton triple action presses and 3,000-ton stamping presses for chassis frame members with dimensions up to 25 ft. between the uprights. It may be noted, moreover, that whereas many of these presses have been supplied to firms in this country, a very substantial export trade has also been built up.

Subsequently—in 1958—Vickers-McKay, Ltd., was formed jointly by Vickers-Armstrongs (Engineers), Ltd., McKay Machine Co., Youngstown, Ohio, U.S.A., and Rockwell Machine Tool Co., Ltd. McKay equipment, which is produced for this company by Vickers-Armstrongs (Engineers), and marketed—as are British Clearing products — by Rockwell Machine Tool Co., includes press feed lines, cut-up lines, tube manufacturing machinery, and machines for forming corrugated and other sections for use in buildings. In particular, reference may be made to Vickers-McKay de-coiling lines, as employed in connection with motor car body production. These lines can be supplied to handle coils of steel strip with weights up to 20 tons and widths up to 6 ft. From the de-coiler the material is passed through a washing section and a levelling machine to the blanking press. Another type of installation, known as the McKay-matic die shear line, incorporates a flying shear of special design for cutting sheets accurately to any length from 12 in. to 83 ft. under an automatic control system which can be programmed manually or by means of punched cards. Sheets are cut at the rate of 30 per min. and average output is of the order of 15 tons per hour. In addition, Vickers-McKay products include slitting lines for strip, and automatic lines for rolling wheel rims for motor vehicles.

To enable the growing demands for British Clearing presses and Vickers-McKay equipment to be met more effectively, a Power Press Division of Vickers-Armstrongs (Engineers), Ltd., was recently formed, and arrangements have been made for production, which was formerly carried out partly at the Elswick Works, to be concentrated at the Scotswood Works of the company, where ample facilities have been provided.

Mr. E. P. Cunningham, senior vice-president

Fig. 1. Equipment in the heavy machine shop of the Power Press Division of Vickers-Armstrongs (Engineers), Ltd., includes these two Asquith floor-type horizontal milling and boring machines, which can be traversed on a common bed

Fig. 2. A T-slot milling operation on a heavy fabricated component is here seen in progress on a Giddings & Lewis 7-in. spindle horizontal milling and boring machine

Clearing Division of U.S. Industries, Inc., and Mr. A. J. Wardle, Jr., president of the McKay Machine Co., recently visited the premises to see the lay-out and equipment of the shops which have been allocated to this work, and they were welcomed by Commander R. B. Lakin, D.S.O., D.S.C., assistant managing director of Vickers-Armstrongs (Engineers), Ltd., responsible for the Northern works.

The Power Press Division now occupies some 25 acres with a covered area of about 400,000 sq. ft., and activities are divided between three departments which are concerned with fabrication, machining, and fitting and erection.

Buildings admirably suited for the work to be undertaken were available, and it may be mentioned that there are facilities for the production of fabricated structures from plate up to 12 in. thick, and of weights up to 100 tons. Four main shops are devoted to the machining of the great variety of components required, including a heavy machine shop which houses an impressive array of large capacity plano milling machines and floor type boring machines.

Equipment in this shop includes the installation shown in Fig. 1, which comprises two Asquith, 6-in. spindle, floor-type milling, drilling, and boring machines mounted on a common bed, on which each column can be traversed for a maximum distance of 63 ft. 6 in. Each spindle head has a vertical traverse of 10 ft., and the work-plate is 85 ft. long by 15 ft. wide. With this arrangement, additional workpieces can be set up while the two spindles are in operation, to ensure maximum machine utilization. In the illustration, the machines in the foreground and the background, respectively, are in operation on the feet of a fabricated bed for a single action double-crank press, and a sliding

Fig. 3. This large capacity Noble & Lund plano milling machine is one of two installed in the heavy machine shop. It is seen set up for finish milling a large bolster plate

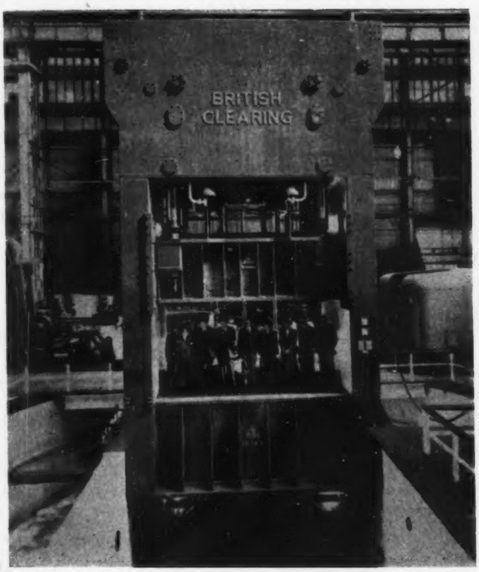


Fig. 4. An example of the heavy British Clearing presses built at the works of Vickers-Armstrongs (Engineers), Ltd. Of the triple-action type, it has a capacity of 1,500 tons

bolster for a die spotting press, and in the centre, a fabricated crown is set up on stands in readiness for machining. Among other Asquith machines may be mentioned two floor-type horizontal milling and boring machines with 7-in. diameter spindles, one of which has a horizontal traverse of 36 ft. and a vertical traverse of 12 ft., the dimensions of the work-table being 20 by 40 ft., and the spindle reach 7 ft. There are also two Giddings & Lewis 7-in. spindle floor-type machines, and that shown in Fig. 2 has horizontal and vertical traverses of 20 and 11 ft., and a 28 by 20 ft. workplate. It is here seen in operation milling the T-slots in the base of the fabricated slide for a Clearing hydraulic die spotting press.

No marking out is performed on the large fabricated components machined on the various horizontal boring and milling machines, all settings being obtained from the accurate scales provided.

In addition, the equipment in the heavy machine shop includes two Noble & Lund plano-milling machines with 8- by 20-ft. tables. Distributed loads up to 80 tons can be supported on the tables of these machines, and the maximum height admitted under the cross-rail cutters is 8 ft. and the maximum width between the side-head cutters, 10 ft. Each head is driven by a 50 h.p. motor, and one of the machines is seen in Fig. 3 set up for finish milling a large bolster for a Clearing press. One of the heavy British Clearing presses which has been built by Vickers-Armstrongs (Engineers), Ltd., is shown in Fig. 4. This triple-action press is of 1,500 tons capacity and was photographed with a group of people standing on the bed to afford a size comparison.

Another example of the work undertaken by the Power Press Division is shown in Fig. 5, where a Vickers-McKay 12-in. by 8-in. by 78-in. special process uncoiler is seen undergoing shop trials. The assembly illustrated comprises the main roll housing, with main drive, also the mandrel carriage with expanding mandrel in the retracted position. Together with the heavy-duty cradle

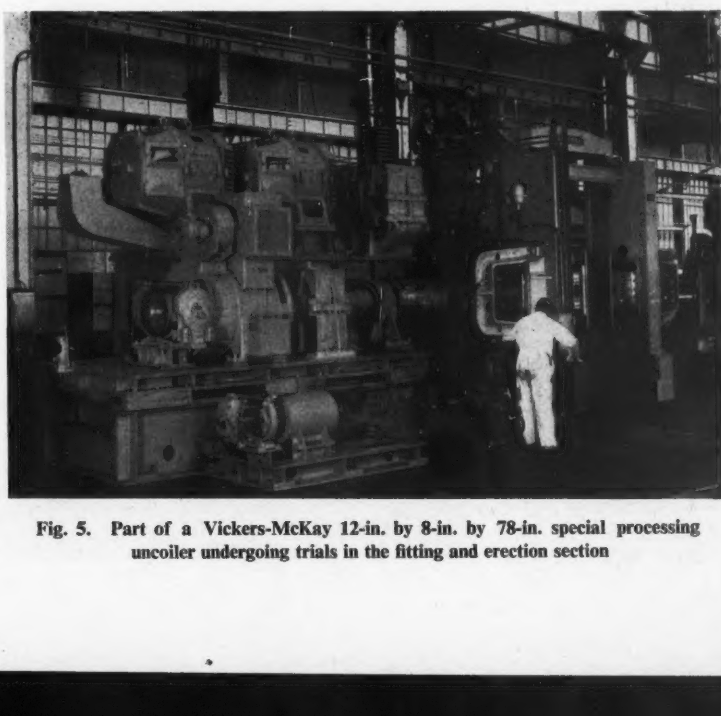


Fig. 5. Part of a Vickers-McKay 12-in. by 8-in. by 78-in. special processing uncoiler undergoing trials in the fitting and erection section

car (not shown) this assembly weighs approximately 150 tons.

The facilities of the Power Press Division include a gear cutting and grinding section, the largest hobbing machine having a capacity for gears up to 6 ft. diameter. In addition there is a tool service room adjacent to the heavy machine shop which is solely concerned with the tooling for the large floor-type horizontal boring and milling machines; a well equipped centralized tool-room; and a temperature-controlled annexe with standards and precision measuring equipment. Machines in the tool-room include a Newall Spacematic, and a Société Genevoise Hydroptic jig borer, and among the equipment in the standards room may be mentioned a Hilger & Watts Microptic universal measuring machine, and a Sigma portable Microtest surface finish comparator.

Appeal to Production Engineers

The President of the Institution of Production Engineers, Mr. Harold Burke, M.I.Mech.E., M.I.Prod.E., F.B.I.M., has sent a letter to each member, part of which is reproduced here.

"The present economic position of the country has been referred to as 'a crisis' or maybe, as 'another crisis.' Depending upon your point of view, you may regard it as an economic crisis or a political crisis. What can we, as an Institution, do about it and what are you going to do as a member of the Institution?

National productivity is the keynote of the situation. The Institution must play a leading part in directing the attention of the Government to what appear to be the weaknesses in their policy; and it must direct the attention of the members to what they can do in dealing with the daily problems of their business.

We have a direct responsibility in our day-to-day application to our professional duties. We form a part of the pattern as a whole and, instead of trying to apportion the blame to other people, I believe that this is the moment for self-examination and self-determination. I have written an article for the October issue of *The Production Engineer* which I hope you will read, but this letter is directed to you as a personal appeal to join with me in influencing the situation we have so closely to hand. Here are a few suggestions:

A—Economists say that a 3 to 4 per cent in-increase in national productivity would considerably stabilize the economy. How far is it possible for you to improve on this within your own administration?

B—Do you regularly examine cost and methods of manufacture to satisfy yourself that you are doing the best you can? However small the organization, it is of paramount importance that a proportion of one's time should be allocated to problems of this nature.

C—Do you find time to keep yourself up-to-date in modern trends of your business by constant study of what other people are doing; and how far does this extend to your colleagues and subordinates?

D—Outside your business, do you exert all the influence you can within the Institution, for example by attending meetings, joining work visits, and taking part in discussions?

E—Do you help by taking part in other local organizations, such as employers' federations, chambers of commerce, etc.?

F—Do you use all the means within your power to spread knowledge of production engineering?

G—Are you at all times *positive and active*, and never negative and passive?

It is planned that a lead will be given in the near future on national level and it is intended to pursue this theme throughout the whole of 1962.

It will be apparent to you that within the Institution we regard the present situation as a challenge which must be met and to which we must apply what remedies lie within our power. I appeal to you therefore to make your own personal contribution towards the improvement of our national productivity."

FLEXOLUX PLASTICS LABELS. Speedwork Systems, Ltd., 18-20 Bowlers Croft, Basildon, Essex, have introduced Wam-Flexolux labels which are made from a plastics sheet material and are stated to be capable of withstanding rough handling and exposure to weather. They are suitable for stapling on to packing cases, for example, and can also be supplied with brass eyelets and wires for attachment direct to components. For use on cases, the labels can be supplied plain or printed in almost any required size up to 6 in. by 9 in., or in continuous lengths. The latter are generally in reel form and pinhole-perforated, and can be over-printed on Wam machines with special Wam-Speedwork weatherproof quick-drying inks. In addition, the material can be marked with chinagraph and waterproof pencils.

Institution of Mechanical Engineers Headquarters

Following the acquisition of premises at 3 Birdcage Walk, Westminster, S.W.1, adjacent to the headquarters building (1 Birdcage Walk) of the Institution of Mechanical Engineers, extensive building alterations have been carried out to enable the increased space thus made available to be used to the best advantage. To mark the completion of this work, the first "open day" ever arranged by the Institution was held on September 27. The entire buildings were then open for inspection by members and their guests, and there was an excellent attendance.

Part of the first floor of No. 3 has been devoted to a library extension which has direct communication with the main library in No. 1 and provides valuable space for expansion to meet the requirements of rapid growth. The remainder of this building is devoted principally to offices, and the rooms of the President and Secretary are on the ground floor. There is also an extensive printing section on the lower ground floor.

As a result of the transfer of various offices to No. 3, space has been made available in the original building for two new committee rooms,

(above Some members of the Institution and their guests inspecting the exhibits in the Frederick Lanchester room

(left) A view in the re-arranged entrance hall of the Institution. The new reception office may be seen in the background, through the door-way. Mr. George Lanchester (second from the right) was among those who attended on the "open day" on September 27

which are known as the Frederick Lanchester and Joseph Whitworth rooms. The former, appropriately, will be used principally for committee meetings of the Automobile Division, and in both rooms are displayed documents and other interesting exhibits associated with these illustrious engineers. The various alterations have been carried out in admirable taste, and it was noted that it has been possible to provide very good standards of accommodation for the staff.

Part of the cost of the alterations was met from a Building Development Fund, to which members of the Institution have now contributed nearly £15,000. Money from this fund was used for the library extension, for the improvement of cloakroom facilities, and for the installation of closed-circuit television which was demonstrated on the "open day", and this equipment will enable proceedings that are taking place in the lecture hall to be relayed.

Gauge and Tool Makers' Luncheon

At a trade luncheon of the Gauge and Tool Makers' Association, Standbrook House, 2-5 Old Bond Street, London, W.1, which was held at the Savoy Hotel on October 3, Sir Stanley J. Harley, B.Sc., M.I.Mech.E., M.I.Prod.E., President of the Association, was in the Chair, and the Guest of Honour was The Rt. Hon. Edward Heath, M.B.E., M.P., Lord Privy Seal. A number of distinguished guests was present and, as is usual, there was a large attendance of members.

In introducing the principal speaker, Sir Stanley Harley said that whatever views one held concerning the application which Her Majesty's Government had made to enter into negotiations for joining the Common Market, or the terms on which we might join, it was desirable that they should be tempered by as much information as possible about the reasons for the application, and the conditions that might be involved.

Replying, The Rt. Hon. Edward Heath said that the application made to the countries of the European Economic Community on August 10 to enter into negotiations had been hailed as a historic decision because it was something far greater than entering into another trade agreement. It was recognized that, provided special arrangements could be made to meet our needs, we now wanted to play our part in establishing greater unity among the countries of Europe.

Considering first the political aspects, the speaker pointed out that the development of the European Economic Community, with a population of 180 million people, could not leave our own position "*vis-a-vis* the rest of the world, the Commonwealth, and the United States in particular, untouched." The British Government, he added, had been worried on account of the two economic groupings in Europe (E.E.C. and E.F.T.A.) and had feared that this economic division would lead to political division between the countries. They had therefore done their utmost to try to bring the two great organizations together.

Mr. Heath also mentioned the political implications of improved living standards which could result from the existence of the Common Market. As to whether the establishment of the European Community would lead to some federation or confederation organization, he could only say that it would be a very bold person who foretold the situation in 10, 20, or 50 years' time.

From the economic standpoint, the Customs Union provided a large market for which modern technological developments could be exploited. "We have seen the growing dynamic within these six countries. We have seen their rapid rate of growth and a great increase in internal trade and also in overseas exports. What is the positive aspect for us? It is that we can share in these opportunities. . . ."

It was true, Mr. Heath continued, that there would be competition from European firms in this country, but that competition would grow in any case. The real issue facing us was whether we were going to compete on our own against the forces that would confront us, or whether we were going to compete with the protection of a much larger market of which we were part. "I should have thought that in industry as a whole there was no doubt about the better of those two courses." The effects on different industries and different firms would vary, but "I believe that on the whole the challenge can be met."

Finally, the speaker went on to discuss the subjects for negotiation, which are related to the Commonwealth, the European Free Trade Association, and agriculture. He did not, he said, underestimate the difficulties of reconciling our legitimate interests, those of the Commonwealth, and those of the European countries, but he believed that if there was goodwill and a realization of the political importance of achieving success, the technical problems could be more easily solved.

The toast of "Our Guests" was proposed by Mr. G. P. Barrott, M.I.Prod.E., Chairman of the Association, and Sir William McFadzean, Chairman of the Export Council for Europe, responded.

NEWS OF THE INDUSTRY

Yorkshire

JACKSTEAD ENGINEERING CO., LTD., Wadsley Bridge, Sheffield, are busy with the production of forging plant and accessories, including steam and air forging hammers, grinding machinery, and friction stamps. This company also manufactures valves and cylinders, and shear blades, and undertakes contract machining of single components and batches of parts. Steady demands are being made on the company's servicing department, which is equipped with large portable machines for carrying out either planned maintenance or emergency repairs to heavy steel works plant "on site." The fabrication department of this company is actively engaged on all types of welded construction, on a contract basis, and heavy-duty profile-cutting equipment is installed in the works.

JOSEPH THOMPSON (SHEFFIELD), LTD., Townhead Street, Sheffield, manufacturers of Summit small tools, inform us that they are experiencing a very heavy demand for all their standard products, which include solid and adjustable reamers; milling cutters; and slitting saws. There is also a steady flow of orders for special tooling. In order to keep abreast of increasing orders the company has instituted a continuous plant replacement programme, to ensure that the various departments have up-to-date machine tools and equipment.

BAKER BLOWER ENGINEERING CO., LTD., Stanley Street, Sheffield, are steadily employed on general maintenance for the engineering industry in the area, on a contract basis, and it was noted that this company manufacture special machine tools for a number of firms, to their own or the customers' designs. We are informed that to meet increasing calls on their services, the company are at present building a new works extension, with an area of some 4,000 sq. ft.

EASTERBROOK ALLCARD & CO. LTD., Albert Works, Penistone Road, Sheffield, inform us that a heavy demand is being experienced for their range of Presto screwing tools, drills, reamers and milling cutters. The recently introduced Whitworth tap set, comprising a range of taps from ⅛ to ½ in. mounted in racks in a metal container, has been very well received in the industry, and we are informed that the company is shortly to introduce a similar set of B.A. taps.

FIRTH BROWN TOOLS, LTD., Speedicut Works, Carlisle Street East, Sheffield 4, report that their works are extremely busy in all departments producing their range of small tools and equipment, which includes Mitia carbide tipped tools; Speedicut H.S.S. tools and drills; Insto segmental type metal cutting saws; Superleda butt-welded H.S.S. tools; Zeelock serrated-blade, milling cutters; and involute gear cutters, for which there is a heavy demand from both home and export markets.

MOORE & WRIGHT (SHEFFIELD), LTD., Handsworth Road, Sheffield, 13, report that their order book is being maintained at a satisfactory level for all the equipment in their range, which includes precision vernier gauges, measuring instruments and engineers small tools. Special attention was drawn to the high volume of export orders at present in hand.

It was stated that the products recently introduced by this company, which include thread gauges, adjustable squares and centre squares, have all been very well received, and that orders for these items have been satisfactory.

DAVY AND UNITED ENGINEERING COMPANY, LIMITED, Darnall Works, Sheffield, a member of the Davy-Ashmore Group of companies, are extremely busy in all departments concerned with the building of rolling mill plant and other steel works equipment, also hydraulic equipment ranging from valves and meters to large presses.

New plant has been installed in the various departments since our last visit, and in the general machine shop we noted a new type W.57, 24-in. swing capacity V.D.F. centre lathe with a 32-ft. 10-in. long bed, and a Milwaukee type 430 vertical milling machine. The toolroom has recently been extended and a tool tipping section has been added, the equipment there installed including a new induction brazing unit and a small milling machine. A Wadkin planing and thicknessing machine and a bandsaw have been provided in the pattern-shop, and new equipment in the fabrication department includes a Lincoln C.O.2 submerged arc welding machine, a Hancomatic profiling machine and a Gibbons gas-fired heat treatment furnace. Five

new electrically-operated overhead travelling cranes have been provided in the machine shop, with lifting capacities ranging from 1 to 2 tons. It was noted that machine tools shortly to be installed include two Scharmann table-type boring machines; a Skoda floor-type ram boring machine; a Heller milling machine; and a 10-in. spindle, Froriep floor-type boring machine.

THOS. C. WILD (MACHINERY), LTD., Vulcan Works, Langsett Road, Sheffield 6, agents and stockists of a wide range of Continental and British machine tools and equipment, inform us that they are experiencing a heavy call for a wide range of equipment from users in all branches of the engineering industry. It was noted that a comprehensive stock of machines is always exhibited in their new showrooms, and machines at present on view include tool and cutter grinders, vertical boring machines, planing machines, milling machines and horizontal boring machines.

THE HEPWORTH IRON COMPANY (ENGINEERING), LTD., Industrial Hydraulic Mechanisms, Hazlehead, report that orders for their range of hydraulic copying units are continually increasing. We are informed that a considerable amount of conversion work on existing machine tools is being undertaken, and that units are now supplied to approximately 80 per cent of the lathe manufacturers in this country for fitting to new machines. The recently-introduced "Junior" self-contained die sinking unit has been very well received, and there has been a large number of enquiries from all branches of the engineering industry. It was noted that operations have now commenced in a new factory extension, which covers an area of some 4,500 sq. ft., and houses the assembly, final testing and inspection departments. A new Churchill slideway grinding machine has recently been installed in the machine shop.

EDWARD PRYOR & SONS, LTD., Broom Street, Sheffield, are very busy producing their range of marking machines and equipment which, we are informed, is in heavy demand throughout the world, from manufacturers of a wide variety of products. This company's services as plate engraving specialists are being well utilized, and it was noted that they are suppliers of a wide range of marking devices, including rubber stamps, stencils and lead seals.

FRANK GUYLEE & SONS, LTD., Archer Tool Works, Archer Road, Millhouses, Sheffield 8, report substantial orders for their various products, and inform us that the shops are at present working to capacity producing plain and revolving lathe centres, lathe mandrels, milling machine arbors, Morse taper sleeves and sockets, and tapping chucks and attachments.

JACOBS MANUFACTURING CO., LTD., Millhouses, Sheffield 8, report an increasing demand for their range of Jacobs chucks. This company is the sole U.K. agent and stockist of the German-made Albrecht heavy-duty keyless drill chuck.

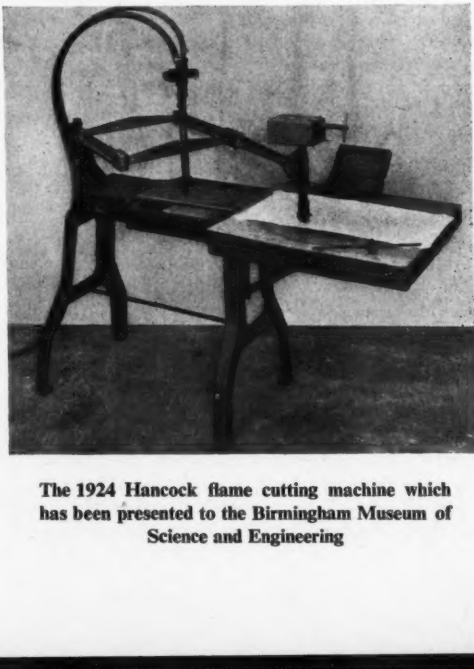
YORKSHIRE PRECISION GAUGES, LTD., Hatfield, Nr. Doncaster, report a continued heavy call for their range of gauging equipment, which includes length gauges from 0 to 48 in. capacity; adjustable caliper gauges from 0 to 36 in.; snap gauges; and standard type plain "go" and "not-go" plug gauges. This company recently introduced an adjustable miniature snap gauge which is now being made to American Standard C.S. 8/51 in a range of four sizes from 0 to 0·195 in. up to 0·570 to 0·760 in. capacity. It weighs approximately 4 oz. This gauge was recently exhibited in Canada and a steady flow of orders has resulted.

An agent has been appointed in France to cover the Continental markets, where a regular trade is being built up, and other export orders are being received regularly from India and the U.S.A.

R. SUTCLIFFE.

An Old Flame Cutting Machine

A competition organized by Hancock & Co. (Engineers), Ltd., Progress Way, Croydon, Surrey, to find the oldest working Hancock flame cutting



The 1924 Hancock flame cutting machine which has been presented to the Birmingham Museum of Science and Engineering

machine in the country attracted much interest, and from details submitted by more than 50 participants it was ascertained that the machine, here illustrated, which was built in 1924 and owned by Davies Bros. & Co., Ltd., Cannock Road, Wolverhampton, merited the title.

In view of the age of the machine, Hancock & Co. arranged for its presentation to the Birmingham Museum of Science and Engineering by Professor E. C. Rollason, M.Sc., Ph.D., of the University of Birmingham, at a ceremony attended by civic dignitaries, directors of the company, including the founder, Mr. J. L. Hancock, Museum authorities, and guests.

The machine, which was demonstrated during the acceptance ceremony using a coal gas/oxygen mixture, has a capacity for cutting steel plate up to 4 in. thick. It has a clockwork-driven tracer head which is arranged for manual guidance, at a speed of 6 in. to 14 in. per min., along an outline drawn on paper to twice full size, and is connected to the burner by a pantograph linkage.

A new type 01 U-arm Hancock flame cutting machine was presented by the makers to the previous owners as a replacement.

The Extending Field for Vapour Blasting and Allied Processes

(*Continued from page* 831)

in preparation for painting. It is reported that considerable economies can be obtained by the use of this equipment and that the surface finish imparted is very satisfactory from the standpoints of paint keying and final appearance.

Apart from the use of jets of water and fine abrasive, or other medium, obtained with or without the application of compressed air, it has been found that the bores of tubes can be effectively treated by the flow of the abrasive-charged liquid under suitably controlled conditions. For this purpose, it is only necessary to pump the liquid through the tube at the required velocity. Originally, this technique was applied mainly for cleaning the bores of stainless steel, copper, and titanium tubes, but so effective has it proved that it is now being adopted for the quantity treatment of mild steel tubes. In addition, it is reported that the method has been used with good results for the bores of tubes made from other metals such as magnesium and beryllium.

It will be evident, therefore, that these water/abrasive mixtures can solve a great variety of finishing and cleaning problems, and it seems probable that they will be used much more extensively in the future when the potentialities become more generally understood.

Non-destructive Testing Conference

The Fourth International Conference on Non-destructive Testing will be held in London from September 9 to 13, 1963, and the arrangements will be made by the Institution of Mechanical Engineers, on behalf of the British National Committee for Non-destructive Testing. The scope of the conference will include all aspects of non-destructive testing, and papers will be admitted under the following headings: basic physics and selection of method; non-destructive testing in general structures, including chemical plant, refineries, buildings, bridges, and power plants; non-destructive testing in transport, including ships and aircraft; and future needs in destructive testing. Prospective authors are invited to write in the first instance, giving the proposed titles of papers, to the Secretary of the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1, for further information and for a guide to the preparation of papers. An exhibition will be arranged in conjunction with the conference, and will be held at the Institution.

Press Steel Co., Training Centre

A new 5-storey training centre with a total area of 30,000 sq. ft. was recently completed for Pressed Steel Co., Ltd., at the Cowley, Oxford, headquarters, and was officially opened by Mr. W. J. Carron, president of the Amalgamated Engineering Union. Built at a cost of £250,000, this centre provides for the initial training of craft and student apprentices for the parent factory, also for specialized courses to meet the requirements of the whole Group. There will, for example, be a full-time course of shorthand and typing; a 2-year full-time course for graduate training; foremanship development courses, each of three weeks' duration; a 6-month full-time course of training for men selected as suitable for promotion for supervisory and superintendent duties; an executive development course for which 10 or 12 men are selected each year on a competitive basis; and special release courses for trade unionists on "industrial relations in the engineering workshop."

Coming Events

INSTITUTION OF PRODUCTION ENGINEERS. *Birmingham Branch.* October 18, at 7 p.m., at the Midland Hotel, Birmingham; lecture on "Recent Developments in Mechanical Transfer for Machining and Assembly," by Monsieur H. Bezier. *Wolverhampton Branch.* October 18, at 7.15 p.m., at the Wolverhampton & Staffs College of Technology, Wulfruna Street, Wolverhampton; lecture on "Shell Moulding and Its Recent Developments," by A. D. Lewis. *Derby Branch.* October 23, at 7 p.m., in the Louis Room, St. James's Restaurant, St. James's Street, Derby; lecture on "Spark Machining as an Aid to Production," by S. V. Divers. *London-Brighton Group.* October 18, at 7 p.m., at the Old Ship Hotel, Brighton; lecture on "Modern Trends in Machine Tool Design," by E. R. Cash. *Luton Branch.* October 24, at 7.30 p.m., at W. H. Allen Sons & Co. Ltd., Bedford; lecture on "Theory and Practice in Engineering Management."

INSTITUTION OF MECHANICAL ENGINEERS. *East Midlands Section.* October 23, at 7.15 p.m., in Room 104, College

of Technology and Commerce, Leicester; lecture on "Machine Tool Research, Design and Utilization," by D. G. Galloway.

INSTITUTION OF ELECTRICAL ENGINEERS. October 23, at 5.30 p.m., at Savoy Place, London, W.C.2.; discussion on "Is Automation Making Satisfactory Progress," opened by Professor A. Tustin.

INSTITUTE OF METAL FINISHING. *South-West Branch*. October 17, at 7.30 p.m., at the Royal Hotel, Gloucester; lecture on "Jig Design and Manufacture," by J. Preston.

Personal

MR. A. E. WATTS, manager of the Birmingham branch of Allen West & Co., Ltd., Brighton, since 1941, has retired. He has been succeeded by his deputy, MR. T. J. OLLIS.

MR. G. W. GIFFIN, M.B.E., F.B.I.M., Director of Manufacture, Associated Electrical Industries (Woolwich), Ltd., has retired after an association of 22 years with the Woolwich company.

MR. J. W. BUTLER, chairman and joint managing director of the Butler Machine Tool Co., Ltd., Mile Thorn, Halifax, and chairman of the Associated British Machine Tool Makers, Ltd., recently left on a business tour which will include Japan, India, and Pakistan. He went first to Boston, U.S.A., where he joined forces with the president of the Lapointe Machine Tool Co., who are agents for A.B.M.T.M. in the United States.

MR. W. C. VICKERS, who joined Ruston & Hornsby, Ltd., Lincoln, in the early days of their gas turbine development, and became chief engineer, gas turbines, in 1956, recently re-joined the company as engineering manager, Turbo Machinery and Allied Products Division. For the past 2½ years he has been with Brown Boveri, Baden, Switzerland, and has been engaged in research and development work on centrifugal and axial compressors.

The following new appointments have been announced:—

MR. RICHARD P. E. TABB as deputy director of engineering of The English Electric Co., Ltd., English Electric House, Strand, London, W.C.2.

MR. P. D. G. HENEKER, formerly personal assistant to the secretary, Mr. W. K. Brasher, to the new post of public relations officer for The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

MR. R. QUIGLEY as home sales manager for Drummond-Asquith, Ltd., King Edward House, New Street, Birmingham, 2. He was previously area manager for the Scottish territory for many years.

DR. W. J. BATES, Ph.D., B.Sc., as chief engineer of R. & J. Beck, Ltd., one of the Griffin & George Group of companies. Pending completion of the new factory at Watford, he will be located at Lister Works, Dickenson Street, London, N.W.5.

A subscription form for MACHINERY appears on advertisement page 189.

Lapping Machine Demonstration

Demonstrations of Lapmaster lapping machines for flat surfaces will be staged at the works of Payne Products International, Ltd., Buckingham Avenue, Slough Trading Estate, Bucks., from November 6 to 17 (Saturday and Sunday excepted). The first Lapmaster 72-in. machine in this country, also 24- and 48-in. machines of new design, and an improved Lapmaster monochromatic lamp unit for use in conjunction with optical flats, will be available for demonstration. Applications for tickets to attend the demonstrations should be made to Mr. Roy Stogdon, Howard Panton, Ltd., Press and Public Relations Department, Panton House, Howard Street, London, W.C.2.

Resistance Welding Demonstration

Meritus (Barnet) Ltd., Barnet, Herts., will stage an exhibition and demonstrations of equipment for spot, stitch, butt, and seam welding, from October 23 to 27. The exhibition will be open daily from 10 a.m. to 5 p.m. and all engineers interested are invited to attend.

Industrial Notes

AN AUCTION SALE OF MACHINE TOOLS and miscellaneous stores will be held at Northern Command Sub-Depot, Nr. Selby, Yorks., on November 1. The auctioneers will be Bartle & Son (Dept. L), 50-52 Merrion Street, Leeds, 2.

A NATIONAL MAINTENANCE EXHIBITION is to be held at the Central Hall, Westminster, from November 13 to 16, and there will also be a 4-day conference of maintenance engineers. The conference and exhibition offices are at 109-119 Waterloo Road, London, S.E.1.

PIONEER OILSEALING & MOULDING CO., LTD., have moved to larger premises at Barrowford, Nelson, Lancashire (telephone, Nelson 62241) on account of the expansion of the business. A previous move, for the same reason, was necessary just over 10 years ago.

SINGLEHURST EQUIPMENT, LTD., specialists in industrial hose and high pressure flexible pipes and fittings, inform us that they have acquired, and now occupy, the entire block of property of which they formerly rented a part at 211 Coventry Road, Small Heath, Birmingham, 10.

GRUNDIG RECORDER PRODUCTION IN ULSTER.—The Grundig factory at Dunmurry, Northern Ireland, recently completed the production of 50,000 tape recorders in a period of seven months. The company's 73,000-sq. ft. factory was built by the Northern Ireland Ministry of Commerce, under the region's Industrial Development Scheme, and provides employment for 450 workpeople, the great majority of whom had had no previous experience of this type of industry.

Obituary

MR. ARTHUR SUNDERLAND, a director of Frank Wigglesworth & Co., Ltd., Shipley, Yorks., we regret to announce, has died at the age of 66. He had been with the company for 32 years, and a director since 1953.

Death of Mr. W. J. Morgan

It is with deep regret that we report the death of Mr. W. J. Morgan, M.B.E., D.L.C., M.I.Mech.E., M.I.Prod.E., on October 4, following a heart attack. Known to his innumerable friends in the machine tool trades and other branches of the engineering industries as Bill, he rendered great services to the industry, first as Secretary of the Machine Tool Trades Association, to which office he was appointed in 1939, and subsequently, from 1951, also as General Manager. As chief executive, he served the Association with distinction until three years ago, when he resigned his posts of General Manager and Secretary, but continued to act as adviser. During the period in which he held office, the Association grew rapidly both in status and membership—the number of member companies was more than doubled, and its influence was substantially increased.

Mr. W. J. Morgan

Mr. Morgan was intimately connected with the war-time control of machine tools as one of the principal spokesmen for the industry, and was instrumental in producing the report on the British machine tool industry, which was submitted to the Director-General of Machine Tools, Ministry of Supply, in 1945. More recently, he was closely connected with the formation of the Machine Tool Industry Research Association, and acted as general secretary of that Association during the early stages of its establishment. He played a prominent part in connection with the first post-war machine tool exhibition at Olympia in 1948, and the exhibitions in 1952 and 1956.

As principal executive of the M.T.T.A., Mr. Morgan was a member of the representative delegation when the Association joined the European Committee for the Co-operation of Machine Tool Industries in 1953. He served on the Committee until 1957, when his first heart attack occurred while he was actually attending a committee meeting.

Mr. Morgan's engineering career began with an indentured apprenticeship at the works of the Bute Shipbuilding, Engineering and Dry Dock Co., Ltd., Cardiff, and for three successive years he was awarded the managing director's prize for the most successful apprentice. Subsequently he took a course in mechanical engineering at Cardiff Technical College where he obtained a diploma with honours.

At the outbreak of the first world war, he joined the Royal Flying Corps and saw service in Egypt, Palestine, and Arabia. He was a member of the renowned "X" flight, 14 Squadron, which was sent to Akaba to assist Col. T. E. Lawrence in his Arabian campaign.

He went to Loughborough College in 1919 for a three-year refresher course in engineering. Here he played a prominent part in the organization of students' communal life and was first president of the Students' Representative Council.

After leaving Loughborough, Mr. Morgan became a partner in the Irish Engineering & Equipment Co., Dublin. Subsequently he returned to England, and temporarily joined the Staff of the Board of Trade. Later he was appointed pump and tank engineer for Red Line Motor Spirit Co., but was soon invited—in 1924—to return to the Board of Trade in the capacity of Chief Examiner, Standards Department. For six years he acted in this capacity, and was closely concerned with the formulation of regulations which, for the first time, brought the petrol pump under control. His department was also responsible for maintenance of Imperial Standards and their periodical verification, and was the central authority for weights and measures administration.

In 1932, he was transferred to the Industries and Manufactures Department, Board of Trade, to handle matters concerned with machinery and non-ferrous metals. With the passing of the Import Duties Act, 1932, the Import Duties Advisory Committee was set up, and Mr. Morgan was seconded to this body and became Technical Adviser, a position which he held for more than six years. During this period he became a familiar figure not only to the machine tool industry, but to makers and users of machinery of all types. He was also a member of the sub-committees of the Committee of Imperial Defence concerned with gauges and machine tools.

Mr. Morgan was awarded the M.B.E. in 1946 for his services to the industry. He was a member of the Institutions of Mechanical and Production Engineers.

Trade Publications

C.M.G. CALVER, LTD., High Street, Bushey, Herts.—Folder concerned with the Revlac range of machine tool equipment which includes an indexing collet chuck, 7½- and 10-in. diameter indexing tables, and a horizontal dividing head.

HENRY WIGGIN & CO., LTD., Wiggin Street, Birmingham, 16.—Publication entitled "The Properties and Applications of 'K' Monel Heat-treatable Corrosion-resisting Alloy," which provides data for the designer mainly in the form of charts and graphs relating to the physical and mechanical properties. There are also sections concerned with available forms and applications.

THE INCANDESCENT HEAT CO., LTD., Gas Atmospheres Division, Cornwall Road, Smethwick, Birmingham.—Publication describing the company's nitrogen and hydrogen plants. Sections are devoted, for example, to standard nitrogen, Hy-nitrogen, Hy-CO nitrogen, and super purity nitrogen plants; standard and Hy-nitrogen from blast furnace gas; Hy-nitrogen from hydrogen and cracked ammonia; and hydrogen plant.

Machine Tool Share Market

Stock markets were quiet during the period under review, but after being dull and uncertain for the most part, gradually tended to rally, and finished on a steady note.

Early easiness in the gilt-edged market gave place to firm conditions, and on balance gains predominated among British Funds and other high grade fixed interest stocks.

Commercial and industrial markets were mainly subdued, and share prices generally drifted to lower levels. Towards the close, however, a brighter tone developed, with fairly active trading, and the final prices recorded were well above the lowest.

Among machine tool issues Edgar Allen advanced 1s. to 33s.; Asquith Machine Tool, 1s. 6d. to 11s.; Sanderson Kayser, 2s. 3d. to 36s.; Stedall & Co,. 3d. to 7s. 9d.; and Tap & Die Corporation, 6d. to 16s. On the other hand, Birmingham Small Arms lost 1s. at 20s.; British Oxygen, 1s. at 17s.; Coventry Gauge & Tool, 1½d. at 30s. 10½d.; Craven Bros. (Manchester), 6d. at 7s. 10½d.; John Harper, 3d. at 7s. 7½d.; Kerrys (Gt. Britain), 3d. at 8s. 3d.; Samuel Osborn, 6d. at 49s.; F. Pratt (Engineering), 6d. at 14s. 6d.; Ambrose Shardlow, 2s. 6d. at 52s. 6d.; and John Shaw & Sons (Wolverhampton), 3d. at 14s. 4½d.

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	1/6
Allen (Edgar) & Co., Ltd.	Ord.	£1	33/-
" "	5% Prf.	£1	13/3xd
Arnott & Harrison, Ltd.	Ord.	4/-	10/6
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	11/-
" " "	6% Cum. Prf.	£1	16/6
Birmingham Small Arms Co., Ltd.	Ord.	10/-	20/-
" " "	5% Cum. "A" Prf.	£1	12/6xd
" " "	6% Cum. "B" Prf.	£1	15/6xd
" " "	4% 1st Mort. Deb.	Stk.	91½
British Oxygen Co., Ltd.	Ord.	5/-	17/-
" " "	6% Cum. Prf.	£1	18/6
Brooke Tool Manufacturing Co., Ltd.	Ord.	5/-	8/-
Broom & Wade, Ltd.	Ord.	5/-	27/-
" "	6% Cum. Prf.	£1	16/6
Brown (David) Corporation, Ltd.	5½% Cum. Prf.	£1	14/-
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/-
Butler Machine Tool Co., Ltd.	Ord.	5/-	15/-
" " "	5% Cum. Prf.	£1	12/6
Churchill (Charles) & Co., Ltd.	Ord.	2/-	8/10½
" " "	6% Cum. Prf.	£1	25/7½‡
Clarkson (Engrs.), Ltd.	Ord.	1/-	6/3
Cohen (George), 600 Group, Ltd.	Ord.	5/-	10/-
" " "	4½% Cum. Prf.	£1	11/6
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	30/10½
" " "	5% Cum. Red. Prf.	£1	16/3
Craven Bros. (Manchester), Ltd.	Ord.	5/-	7/10½
Elliott (B.) & Co., Ltd.	Ord.	1/-	2/6
" "	4½% Red. Cum. Prf.	£1	11/3
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	10/-
Greenwood & Batley, Ltd.	Ord.	10/-	16/3
Harper (John) & Co., Ltd.	Ord.	5/-	7/7½
" " "	4½% Red. Cum. Prf.	£1	11/6
Herbert (Alfred), Ltd.	Ord.	£1	66/6
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	20/-
" "	"B" Ord.	5/-	16/3
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	25/6
	7% Cum. Prf.	5/-	4/6
Kearney & Trecker-C.V.A., Ltd.	5¼% Red. Cum. Prf.	£1	8/9
" " "	Prefd. Ord.	£1	13/9
Kearns (H. W.) & Co., Ltd.	Ord.	5/-	21/3
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	8/3
Macreadys Metal Co., Ltd.	Ord.	5/-	15/-
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/6
Massey (B. & S.), Ltd.	Ord.	5/-	11/6
Newall Engineering Co., Ltd.	Ord.	2/-	7/-
Newman Industries, Ltd.	Ord.	2/-	7/-
" "	6% Prf. Ord.	5/-	5/-
Noble & Lund, Ltd.	Ord.	2/-	5/9
Norton, W. E. (Holdings), Ltd.	Ord.	2/-	8/-
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	49/-
" " "	5½% Cum. Prf.	£1	22/-
Pratt (F.) Engineering Corporation, Ltd.	Ord.	5/-	14/6
Sanderson Kayser, Ltd.	Ord.	10/-	36/-
" "	6½% Cum. Prf.	£1	16/3
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	8/6
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	52/6
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	14/4½
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	19/-
" " "	5% Cum. Prf.	£1	13/3
Stedall & Co., Ltd.	Ord.	5/-	7/9
Sykes (W. E.), Ltd.	"B" non-voting Ord.	10/-	25/7½
Tap & Die Corporation, Ltd.	Ord.	5/-	16/-
" " "	4½% Deb. 1961-1977	Stk.	81½
Wadkin, Ltd.	Ord.	10/-	26/-
Ward (Thos. W.), Ltd.	Ord.	£1	70/-
" "	5% Cum. 1st Pref.	£1	13/6
" "	5% Cum. 2nd Pref.	£1	20/-
Willson Lathes, Ltd.	Ord.	1/-	3/-

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. ‡ Birmingham price.

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In the short run, too

It is not only in the long run that Araldite proves so economical. For short runs, calling for tools which can be made quickly and cheaply, Araldite epoxy resins offer many advantages. These include: high strength and dimensional stability; resistance to wear and freedom from deterioration; excellent adhesion to many materials, facilitating bonding and the use of fillers or metal inserts; ease of manufacture from moulds of many materials; ease of modification in the event of change of design; suitability for making tools of any size. For the past ten years, Messrs. A. V. Roe & Co. Ltd. have used Araldite to manufacture large press tools for aircraft production. The photograph shows a freight door-frame measuring 84" by 60" by 4" for the new Avro 748. It is formed in 14 s.w.g. light alloy by an Araldite-faced double action draw tool, which has already produced over 100 pressings.

May we send you our booklet 'Araldite Resins for Tooling'?

Araldite epoxy resins are used

for producing patterns, models, jigs and tools.

for casting high grade electrical insulation.

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as fillers for sheet metal work.

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AP 645

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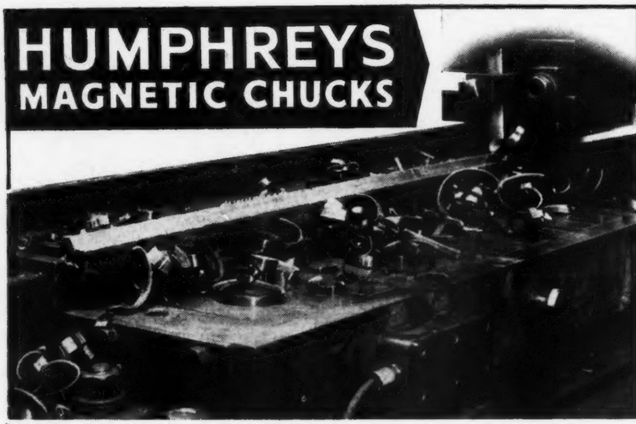

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The HUMPHREYS magnetic chuck with suitable stop and supports grips the section of 60 lb. rail without resort to clamps of any kind whilst a reasonably heavy cut $\frac{5}{8}$ in. deep x .040 in. feed is taken.

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May we send you a leaflet?

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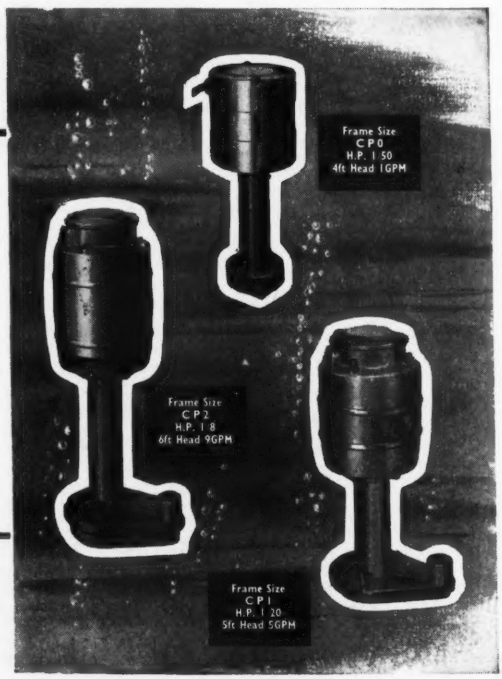

CARTER ELECTRICAL COMPANY LTD
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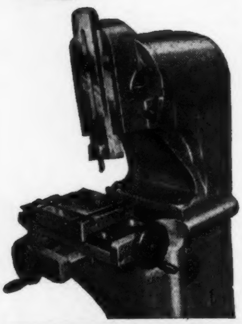
SAVE 25% PRODUCTION TIME!

Leytool 2-inch Stroke Slotting Machine



THE Leytool Slotting Machine is a development of necessity to provide economic manufacture of the 1001 small parts which no other machine can handle. So successful was this machine in their own works that the designers, The Leytonstone Jig and Tool Company, have now developed it to play an invaluable part in both small and large machine shops.

Sturdy, well-built and comprehensive in its uses on production machining of small parts, this machine has accuracy, adaptability and unique features of the greatest possible value in the toolroom. A "great" little machine which in initial cost, production time and trouble-free service offers a 25% overall saving in manufacturing costs of any part.

MARK II This is a simplified version of the Mark I model, constructed from the same heavily designed main castings, but not incorporating the Rotary Table. The two cross slides are hand fed only and the 7in. by 6½in. rectangular Tee Slotted Table is designed primarily to accommodate production tooling.

MARK I This model is fitted with a very serviceable 7in. diameter Rotary Table, which has been specially hardened, ground and graduated. Rapid, precise setting to within 1/1000th of an inch is provided by the accurately ground centre bore and tenon slots.

Designers and Manufacturers: The Leytonstone Jig and Tool Co. Ltd.

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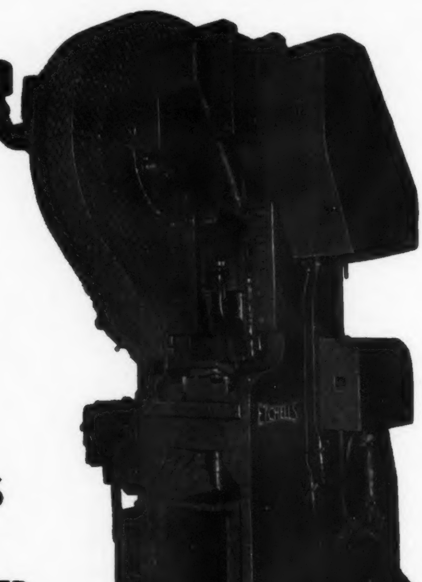
20 FORGINGS per minute!



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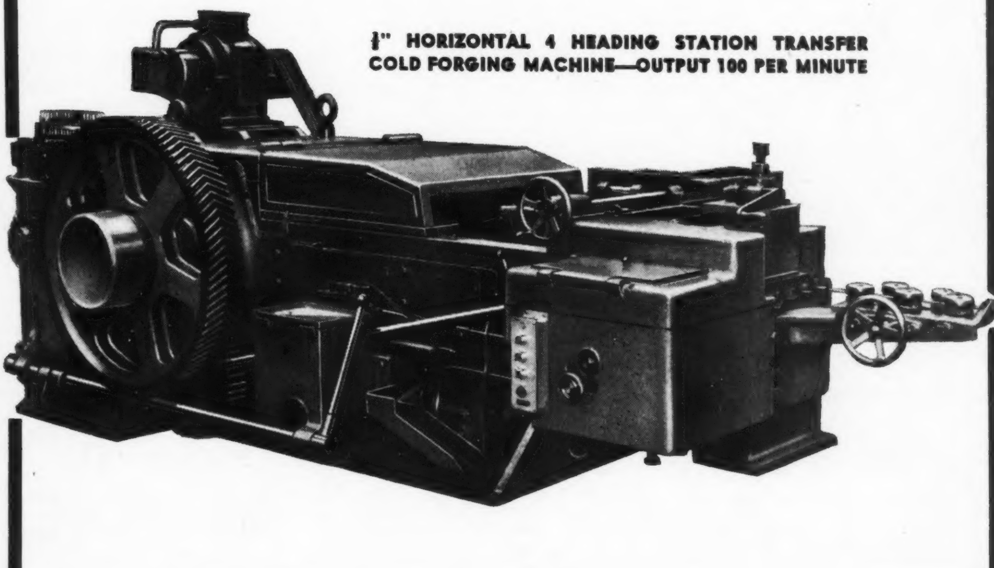
$\frac{3}{8}$" HORIZONTAL 4 HEADING STATION TRANSFER COLD FORGING MACHINE—OUTPUT 100 PER MINUTE



This $\frac{3}{8}$" Horizontal 4-station transfer Cold Forging Machine has an output of 100 per minute. It will cut off lengths of $4\frac{1}{2}$" with a cut-off capacity of 9/16" diam. on high tensile steel wire. Special features include the punch and die ejectors, fitted with electrical safety devices so that in the event of a tooling failure the machine is stopped almost instantaneously by motor plug brakes working in conjunction with a powerful band brake. The machine is fully automatically lubricated and can be supplied with a variable speed drive.

Also available is a complete range of standard and high speed, single and double blow, open and solid die cold forging machines; reheading and trimming machines; thread rolling machines, etc.

Advice willingly given on any manufacturing problems connected with cold or hot forging.

GREENWOOD & BATLEY LTD.

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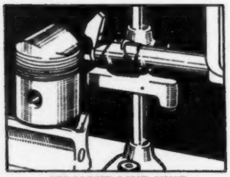
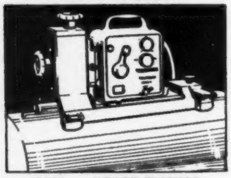
Accessories for "TALYSURF" 3



STRAIGHT LINE UNIT



ROLL and BORE FIXTURE

SMALL BORE PICK-UP with skid nosepiece will enter bores down to ·25" diameter. With independent datum provided by the STRAIGHT LINE UNIT (as illustrated) will enter bores down to ·08" diameter or grooves ·055" wide.

ROLL AND BORE FIXTURE. Mounts the "Talysurf" gearbox and pick-up directly on to large components which cannot be accommodated on the instrument.

ADAPTOR. Mounts the Series 3 "Talymin" Side Acting Gauge to the "Talysurf" gearbox to serve as a low magnification pick-up.

REPLICA KIT. Replica material enables evaluation of surfaces normally inaccessible to a "Talysurf" pick-up.

RECESS PICK-UP. For measuring surface finish at the bottom of recesses up to 5/16" deep.

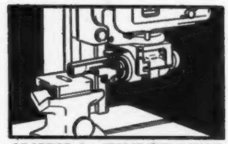
X500 DRIVE UNIT. Provides a means of obtaining a horizontal magnification of X500. Attaches to standard gearbox.

RIGHT ANGLE ATTACHMENT. Enables measurements to be made between deep shoulders, as for example, on crankshafts.

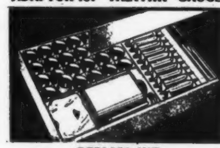
HIGH RESOLUTION PICK-UP. For measuring surface finish of very fine surfaces such as gauge blocks. Has a specially sharp stylus.

Other Special Accessories are available

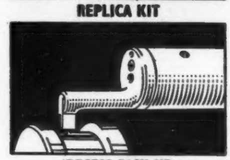
TAYLOR-HOBSON



ADAPTOR for 'TALYMIN' GAUGE

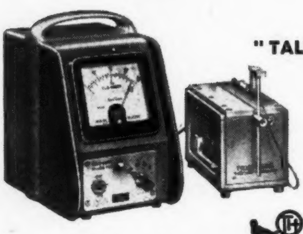


REPLICA KIT



RECESS PICK-UP

X500 DRIVE UNIT



PORTABLE SURFACE MEASURING INSTRUMENTS

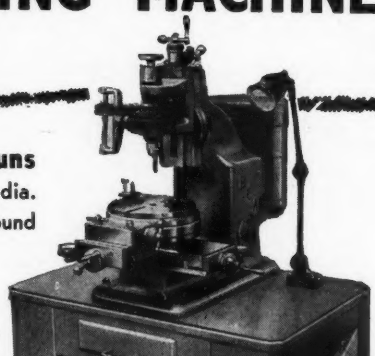
"TALYSURF" MODELS 101 and 105 Portable Surface Measuring Instruments

Accurate and robust instruments, suitable for inspection in the workshop. Model 105 provides CLA or AA readings with ·03" (0,8mm.) cut-off. Model 101 with ·01" (0,25mm.) cut-off is suitable for the measurement of short surfaces. Main feature of the Model 105 is its application to the measurement of bores down to ¼" (6mm.) diameter to a depth of 10" (254mm.). Special work-holding fixtures are included.

A Division of Rank Precision Industries Ltd. **TAYLOR, TAYLOR & HOBSON, Leicester, England**

For precision at low cost THE MARK III

B.C.A. JIG BORING MACHINE £352



Ideal for your Toolroom small production runs

BRIEF SPECIFICATION: Boring up to 1½" dia. Table 8" dia. 11 Speeds. 300 to 3,250 r.p.m. Lead screws hardened & Ground

PRICE £352 BASIC MACHINE EX-WORKS Including Two-speed Motor, Cabinet extra.

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- ***No Drilling Jigs***
- ***Positional Accuracy to ±.001"***
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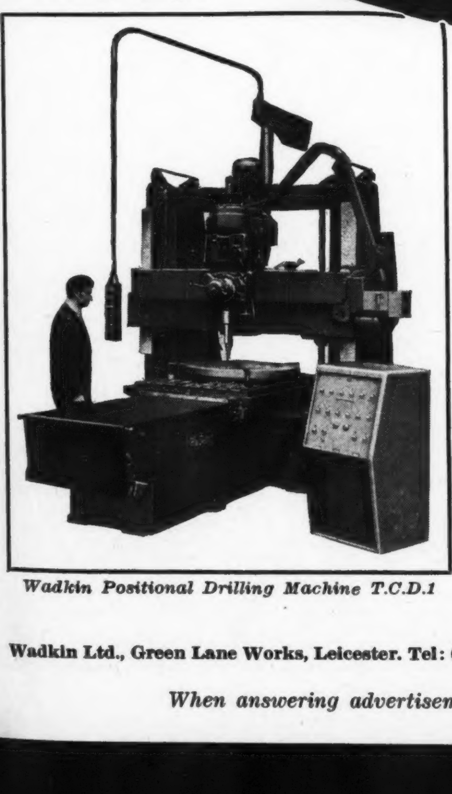
- ***Tape or Dial Setting***

Photographs by courtesy of A.E.I. Ltd, Glasgow



Wadkin Positional Drilling Machine T.C.D.1

This machine will accurately position holes up to 2in. diameter in steel. It eliminates all marking off as well as the necessity of using drilling fixtures. Once the tape has been punched—a relatively simple operation—exact repetitions of even the most complicated drilling jobs are guaranteed at any time. The rigidity of the machine enables maximum diameter drills to be fed directly into steel without the break-through problem normally experienced. The price of this machine, complete with positioning control system, compares favourably with a conventional drilling machine of the same capacity. Either single or multi-station turret heads can be fitted. May we send you more details?

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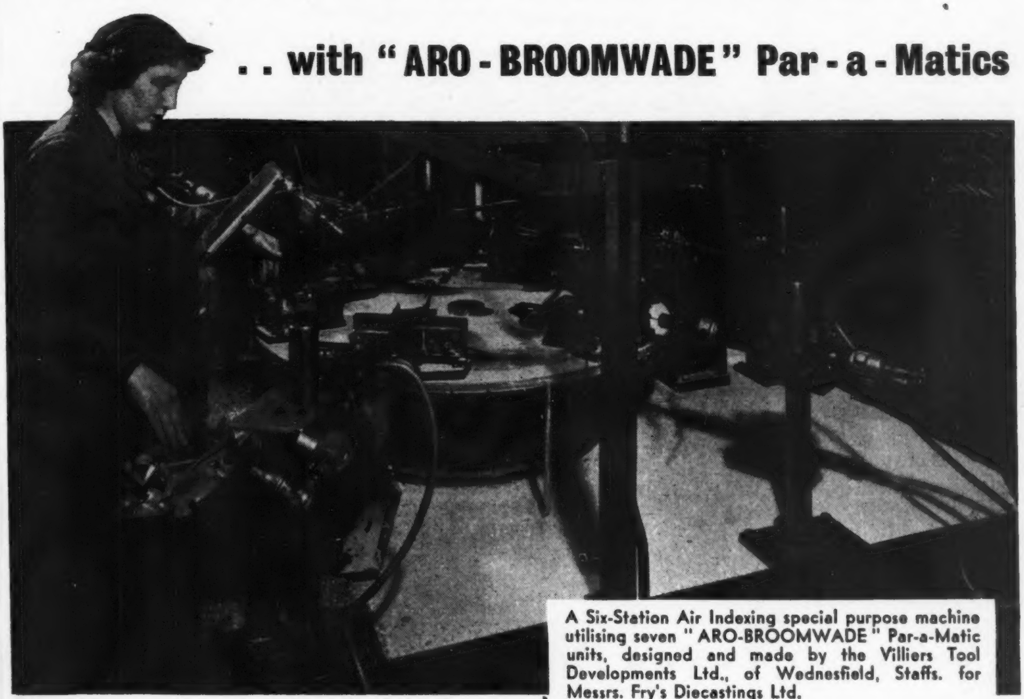
. . with "ARO - BROOMWADE" Par - a - Matics



A Six-Station Air Indexing special purpose machine utilising seven "ARO-BROOMWADE" Par-a-Matic units, designed and made by the Villiers Tool Developments Ltd., of Wednesfield, Staffs. for Messrs. Fry's Diecastings Ltd.

This machine carries out the following sequence of operations at a **production rate of 150 per hour. Previous methods produced only 200 per day.**

1st Station ...	**Drill 2 holes for u.n.f. tapping**
2nd Station ...	**... Tap 2 holes 10 u.n.f.**
3rd Station ...	**Drill 2 holes for 6 BA Tapping (Multi-head)**
4th Station ...	**... ... Tap 1 hole 6 BA**
5th Station ...	**... ... Tap 1 hole 6 BA**
6th Station ...	**Unload fixture & load fresh component**

Special note should be made of the 2-spindle drilling head attached to the PAR-A-MATIC for drilling the two close-spaced holes at Station No. 3.

Photograph by courtesy of Messrs. Fry's Diecastings Ltd.

From 200 per **day** to 150 per **hour** — this is the remarkable increase that "ARO-BROOMWADE" Par-a-Matics have effected in the production of automobile door handles for Messrs. Fry's Diecastings Limited.

Here is but one of the many examples where the speed and versatility of "ARO-BROOMWADE" Par-a-Matics makes really substantial savings and increases production.

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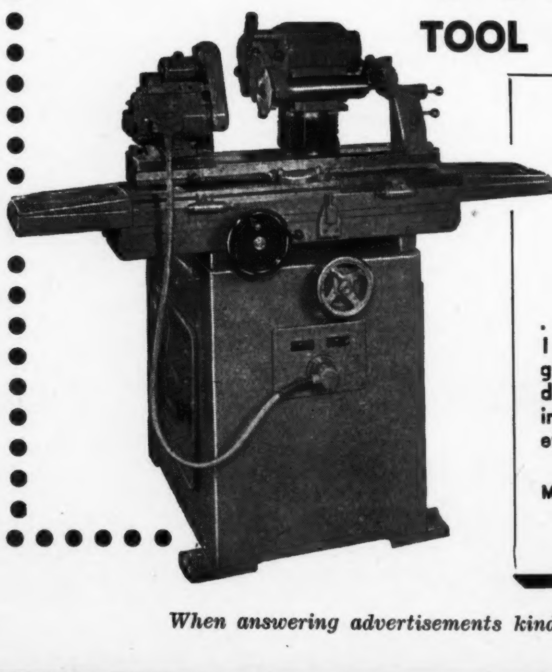

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PRICE **£533**

. . . . also available with capacity of 11" x 24" wet grinding equipment, internal grinding attachment, collet attachment, dividing head, chucks, long surface grinding quill, dead centre grinding attachment, etc.

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on capstans, autos and lathes

"Stellite" 39 H.D. is designed to eliminate trouble

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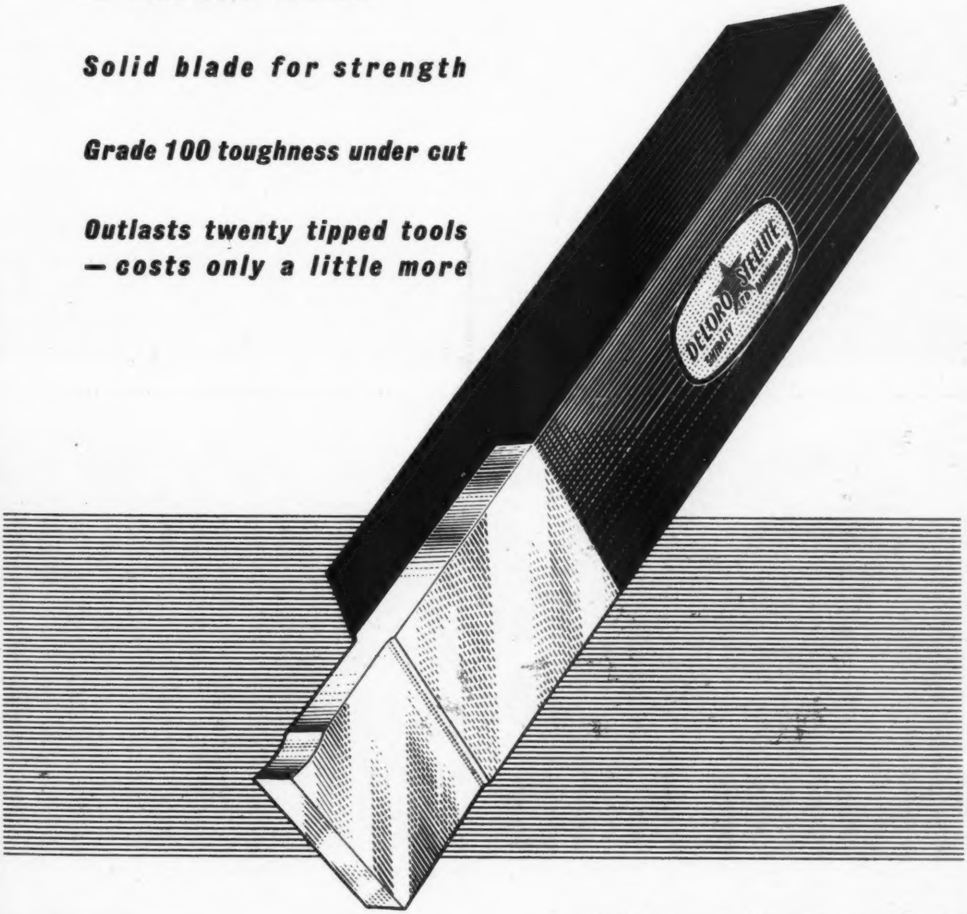
Grade 100 toughness under cut

Outlasts twenty tipped tools — costs only a little more



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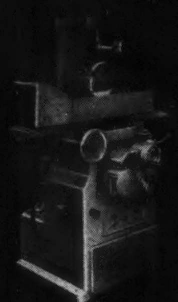

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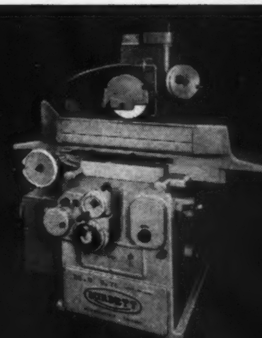

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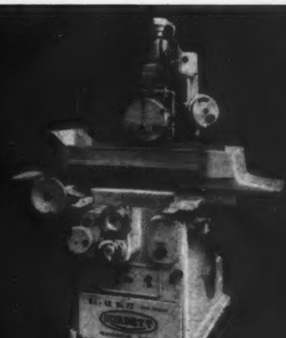

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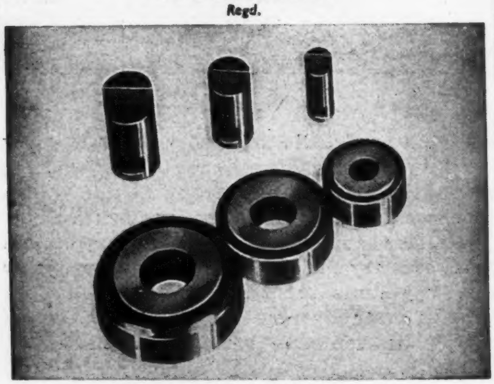

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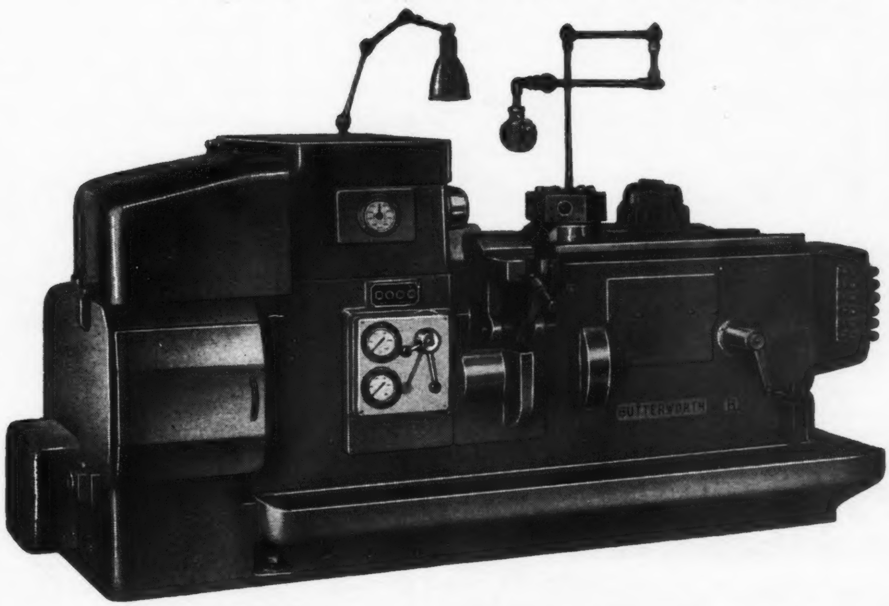

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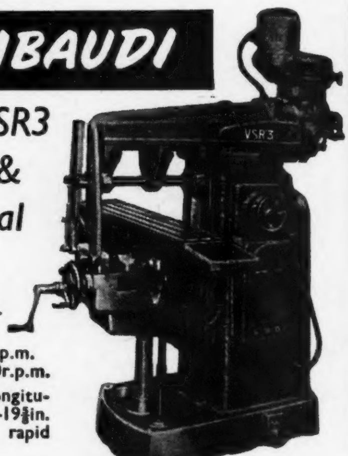

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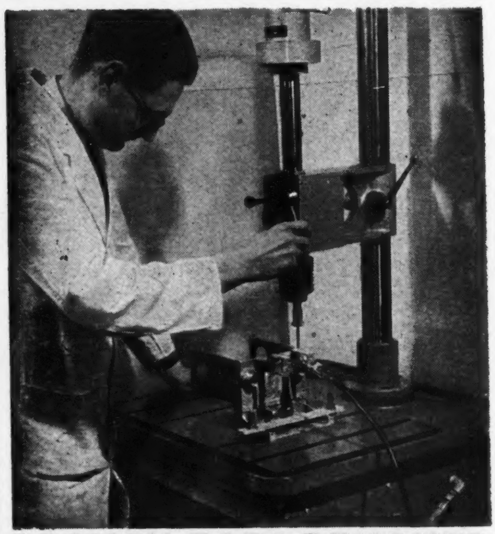

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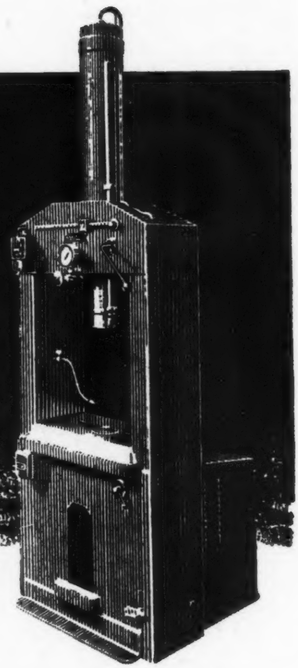

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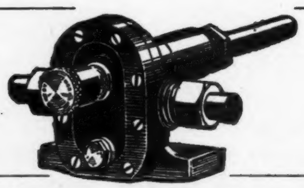

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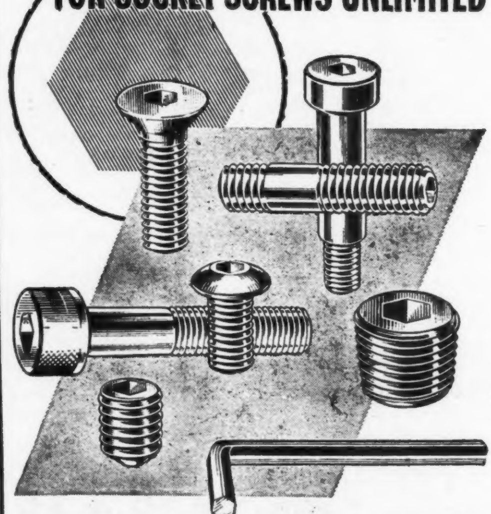

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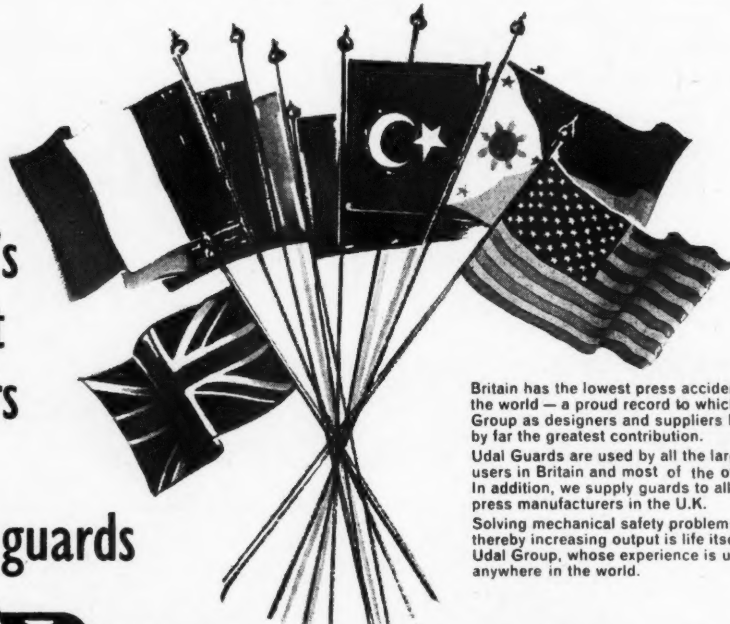

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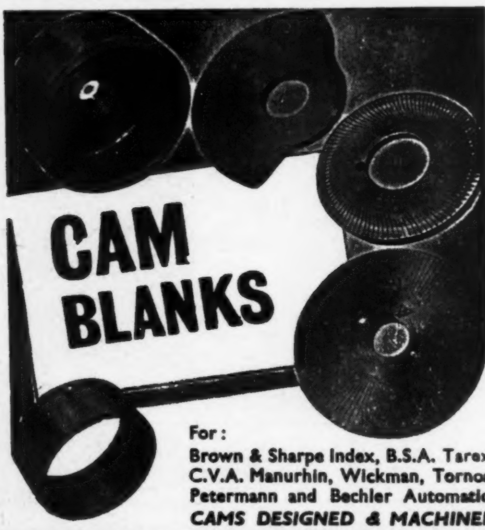

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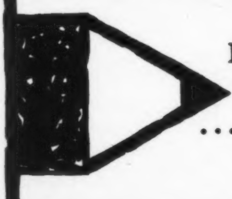

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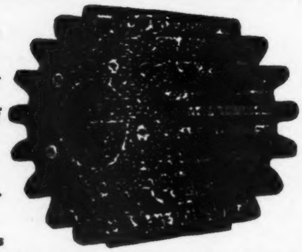

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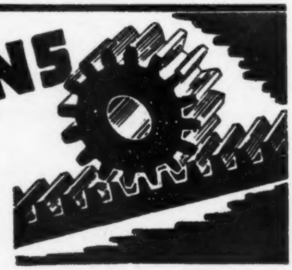

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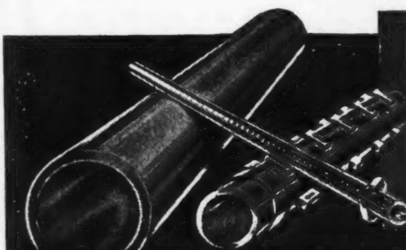

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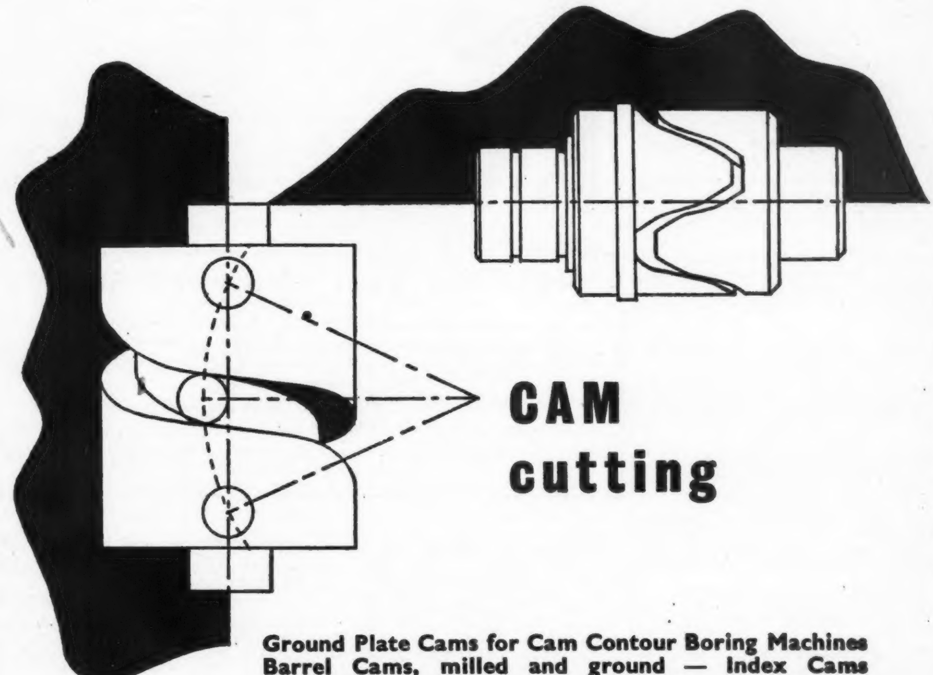

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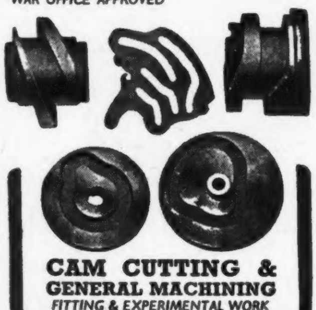

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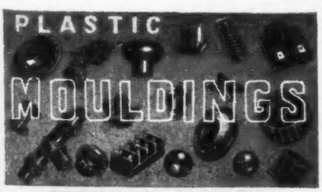

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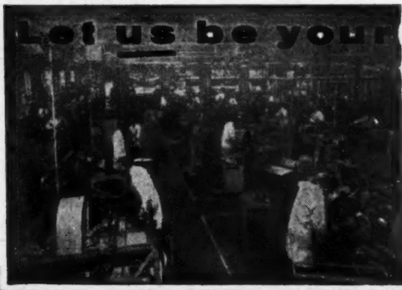

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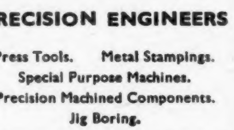

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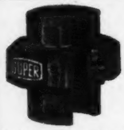

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HERBERT 2S, Flamard Bed.
WARD 1A.
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New High Grade Swedish Horizontal Boring and Milling Machines. Model AV 75. 3in. dia. traversing spindle, 28in. capacity facing head. Stock delivery from London. SOLE BRITISH AGENTS.
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TOWN 5ft. Radial Drilling and Tapping Machine. Model C.1; spindle No. 5 M.T. Drilling capacity 3in. Tapping capacity 2in.
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BARBER COLMAN 12in. Gear Hobber
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FELLOWS No. 6 and 612 Gear Shapers; 35in. × 5in. capacity.
FELLOWS No. 61A Gear Shaper 18in. × 5in. capacity.

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NEW 3½in. × 14in. Universal Grinders.
MATRIX 1A Universal Grinder, 9in. × 24in.
CHURCHILL 12in. × 36in. Hydraulic Universal Grinder.
CHURCHILL 16in. × 50in. Universal Tool and Cutter Grinder.
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WARD 7, 2in. capacity (no covered bed, apron missing).
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WARD 3A, 2in. capacity, air collet and bar feed, power saddle.
WARD 2A, 1¼in. capacity, collet head.

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WARD No. 16, covered bed, 8½in. spindle, 32in. 4-jaw chuck, rapid and power feeds to saddle, cross slide and turret, power rotating turret, spindle speeds 7-225 r.p.m., 50 h.p. motor.
WARD No. 10B, covered bed, 4½in. spindle, power rotating turret, power and rapid feeds to turret only, collet head and bar feed.
WARD No. 7, 2½in. capacity, covered bed, chucking.
HERBERT No. 7A, covered bed, air chucking, well equipped.

TAPPING MACHINES

HERBERT No. 2 Flashtap, ½in. capacity.

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SUNSTRAND No. 2 Electromil, automatic cycle, 54in. by 12in. table.
EDGWICK No. 2, prismatic overarm, 42in. by 11in. table.
JONES & SHIPMAN duplex slot miller, hydraulic feeds.
HERBERT 3ND, prismatic overarm, 58in. by 15in. table, 36in. auto feed.
CENTEC model 3R, electronic control high speed production mill, 34in. by 11in. table, 14in. stroke, spindle speeds to 3,000 r.p.m.

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WADKIN highspeed for light alloy, 40in. by 16in. table.
HERBERT 15S, 48in. by 11in. table, sliding head.

GRINDING MACHINES

BROWN & SHARPE No. 2 surface grinder, 18in. by 6in. capacity.
WICKMAN 14in. double-sided tool grinder with canting tables.

MISCELLANEOUS

HERBERT power hack saw blade sharpening machine.
SWEENEY & BLOCKSIDGE fly press.
E.M.B. air press.
AVERY computor scales 1-10 and 1-100
SUNNEN honing machine.

Newman

AUTOMATICS

BULLARD Multi-Au-Matic 7in. 8 spindle
BULLARD Multi-Au-Matic 12in. 6 spindle.

BORING MACHINES

WETZEL Horizontal traversing column Floor Boring and Facing Machine, 7in. diameter travelling spindle, 45in. diameter facing head. (Two available)
KEARNS Model OB Horizontal Boring and Facing machine, 2¼in. diameter travelling spindle (1957).
UNION Model BFT100 Horizontal Boring and Facing Macine, 4in. diameter travelling spindle (1955).
KEARNS Model OC Horizontal Boring Machine, 3in. dia. travelling spindle.
WEBSTER & BENNETT Vertical Boring Machine, table 50in. diameter.
RICHARDS Type PRT Horizontal Floor Boring Machine, 3½in. travelling spindle, 28in. diameter facing head.

CAPSTAN AND CENTRE LATHES

CHURCHILL-REDMAN Model 13NM Heavy-Duty S.S. & S.C. Gap Bed Centre Lathe, 13in. centre height × 72in. between centres Swing in gap 50in.
MITCHELL Model DM10 S.S. & S.C. Gap Bed Centre Lathe, 10½in. centre height × 7ft. 5in. between centres. (NEW.)
OLDFIELD & SCHOFIELD Surfacing and Boring Lathe, 10½in. centre height.
WARD 7B Combination Turret Lathe.
NILES Heavy Duty Centre Lathe, S.S. & S.C. 17in. centre height × 28ft. between centres.
U.L.R.O. Heavy Duty Centre Lathe, 16in. centre height × 30ft. between centres.

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ASQUITH Model OD.1 5ft. Elevating Arm Radial Drilling Machine.
HETTNER Radial Drilling Machine, 10ft. elevating arm.

GEAR MACHINES

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GLEASON 3in. Straight Bevel Gear Generator.

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CHURCHILL Plain Cylindrical Grinding Machine, 26in. swing × 84in. between centres (1951).
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ORCUTT Model HM24 Internal Spur Gear Grinding Machines
CHURCHILL Plain Hydraulic Cylindrical Grinding Machine, 20in. swing × 54in. between centres.
BROWN & SHARPE Plain Cylindrical Grinding Machine, 10in. swing × 36in. between centres

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CINCINNATI Model 5/72 Plain Hydromatic Milling Machine, table 91in. × 22in. (1952).
CINCINNATI No. 2L Plain Horizontal Milling Machine, table 52in. × 10in.
CINCINNATI No. 1M Vertical Milling Machine.
PRATT & WHITNEY Model BL3620 3-spindle "Keller" Die Sinking Machine.
CENTEC Model 3R Automatic Production Milling Machine, table 25in. × 16in.

MISCELLANEOUS

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TAYLOR & CHALLEN Double Sided 50-ton Geared Power Press, 10in. stroke.

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ASQUITH two Spindle Profile Milling Machine Capacity 24in. by 28in. Spindle speeds 250 to 3,000 r.p.m.

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TRIDENT Model V.O. Swivel head Vertical Milling Machine. Table W.S. 30in. by 8in. Spindle speeds 130 to 800 r.p.m.

CHURCHILL Horizontal Spindle Surface Grinder. Table W.S. 13in. by 36in.

DISKUS Vertical Spindle Surface Grinder, hydraulic. Size of table 53in. by 10in. 14in. dia. segmental wheel.

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PFAUTER R.S. 11 Horizontal Gear Hobbing Machine.

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WARD No. 2A Capstan Lathe, with ball chuck and bar feed.

WARD No. 2A Capstan Lathe, with power feed to saddle.

WARD No. 3A Capstan Lathe, with ball chuck and bar feed.

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HERBERT No. 2B Capstan Lathe, chucking.

HERBERT No. 1S Capstan Lathe, chucking.

TWO MOREY No. 2G Capstan Lathes, chucking. 1in. capacity.

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HERBERT Single Spindle Drilling Machine on 2 spindle base, geared automatic feed, air operated. No. 3 M.T. Table W.S. 14in. by 22in.

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ALBA 18in. Crank Shaping Machine.

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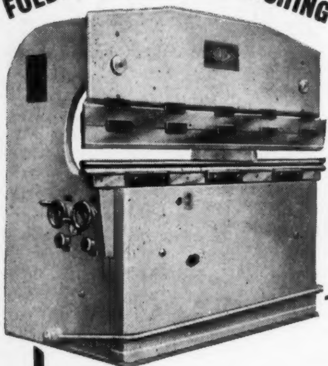

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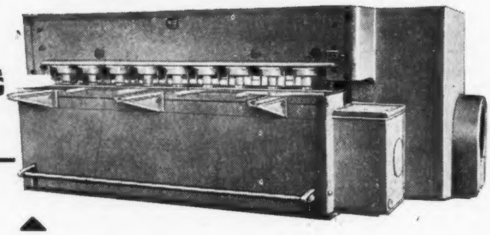

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WARD 3A Capstans.
WARD 2A Capstans.

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WADKIN High Speed Vertical, Table 35in. by 13in.
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ALBA 14in. stroke.
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MINIMUS Gear Hobber. Similar to Mikron 79.

WICKMAN Model 14C Grinding & Lapping Machine. Takes 14in. × 2in. wheels.

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8½in. **LANG** S.S. & S.C. Lathe. Admits 4ft. 0in. between centres.

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MONARCH Centre Lathe. Swing over hardened V bed 20½in.; between centres 48in. Taper turning.

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ORMEROD 8in. Production Slotter.

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TWW

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CHURCHILL-REDMAN 18½in. centres S.S. & S.C. Lathe to admit 10ft. 0in. between centres, swing in gap 62in. × 19½in., hollow spindle 5⁷⁄₁₆in., 8-253 r.p.m., Norton type box, 4-way toolpost, rapid traverse to saddle.

WARD Model 1A Capstan Lathe, hole in spindle 1⅛in., spindle speeds 20-4,310 r.p.m., swing over cross slide 6½in., over bed 10in.

NEWALL type L Hydraulic Plain Cylindrical Grinding Machine, 10in. × 36in. cap. suds pump and piping.

PFAUTER Model RS.9 Gear and Spline Hobbing Machine, max. hobbing length (tooth face) 19¾in., max. dia. hobbed 10⅝in., max. pitch hobbed 2½in.

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Olivetti Kneeless Auto-cycle Pro-duction miller, 27in. trav., 44in. × 12in. table. Unused except for demonstration, reasonable offer accepted.—C. L. THOMAS, LTD., Stirling Road, Solihull. Tel.: 3075-6.

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Kitchen & Wade 4ft. 6in. Radial Drill; 2 motor type; speeds up to 1,500 r.p.m. at present D.C. Voltage but will be converted to A.C.

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3-Wire Automatic Straightening and Cutting-Off Machine for sale. With extra heavy type spinner straightener which may be mounted on bed and used for straightening and cutting a single heavy wire. Capacity, 3 wires, 14 s.w.g., single wires, ¼in. Cuts of any length up to 36ft. Complete with coil holder. Arranged motor drive, 400/3/50.—F. J. EDWARDS LIMITED, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3.

Kearns No. 1 Horizontal Boring and Facing Machine, complete with Rear Stay. A.C. Motor.

Further details from:—
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Maag S.F.½ Gear Grinder—Very well equipped.—C. DUGARD, LTD., Denmark Villas, Hove 32471.

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CONOMATIC 1⅛in. 8-spindle Type W.W.
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UNION Model BFT 100/11. 4in. spindle.

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ASQUITH 4ft. O.D.1 Radial Drill.
PROGRESS 5E Round Table.
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MAS Model V.R.4, 4ft. 6in., Elevating Arm Radial Drill.

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SOUTHBEND 16in.
EDGWICK 7in.
DEAN, SMITH & GRACE. Height of centres 7in.
MONARCH 22M, S.S. Taper Turning Lathe.
WARD 10 Combination Turret Lathe.
WARD 7 Combination Turret Lathe.
LANG 10½in. Gap Bed. 5ft. between.

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18in. **EDGWICK** Production Mill.
CINCINNATI No. 5 High Power Plain Hor. 1942 machine.
MILWAUKEE 2 HL Vertical—rebuilt.
MILWAUKEE 2K Plain—overhauled.
MILWAUKEE 3KM Universal, metric, with dividing head.
PEGARD Bed Type Vertical, table 84in. × 29in.—slightly used.
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TRIUMPH 6ft. × ⅛in. Overcrank.

All machines motorised 400/3/50

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PADDON Mk. 3 type WP Cylinder Re-Boring Machines.

HONING AND LAPPING

DELAPENA Honing Machine.

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GISHOLT No. 3 Capstan Lathe.
HERBERT No. 2 Pre-optive Bar Turret Lathe. Flamard bed, 2in. capacity with bar feed, full turret tooling.
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MURAD $\frac{5}{8}$in. capacity with full equipment.

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CARDIFF 7in. Lathe, full equipment.
WILLSON 7$\frac{1}{2}$in. Newel Lathe.
SOUTHBEND 7in. Centre Lathe.
CRAVEN Heavy Duty Railway Wheel Lathe, swing 6ft. by 12ft., vee belt drive. Weight 25 tons.
New **CAPITOL** 9$\frac{1}{2}$in. Centre Lathe admitting 6ft. between centres.
FACEPLATE Lathe, 9ft. swing.
DEAN, SMITH & GRACE 9in. by 5ft. 6in. Centre Lathe.

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OLIVETTI Model R 4-500 plain cylindrical grinder (1953).
MOPCO Model RUP 108YW. Combination horizontal and vertical spindle toolroom hydraulic Surface Grinder, table 38in. by 11in. (1953).
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SCRIVENER No. 1 Centreless Grinder.
BLAKE No. 1 Tap Chamfering Machine (New).
MATRIX No. 6 Internal Thread Grinders 3in. by 10in.
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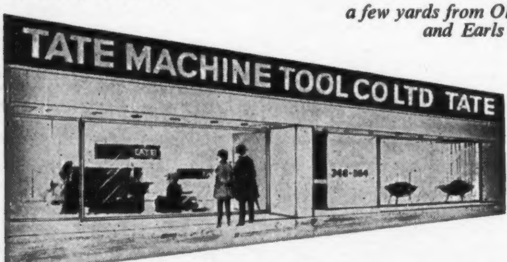

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STIRK 16ft. by 5ft. double column Planers, four toolboxes; modern machines with Lancashire drive (Two).
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RHODES 1-Ton Open Fronted Bench Press with flange motor and UDAL guards.
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Six New **MULLER** Model AMP 22-ton Power Presses. Complete with horn.
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New **LIMA** 22in. Shaper.

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WESPA AS4 Bandsawing and Bandfiling Machine, hydraulic feed (similar Do-all V/16).

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TIMBRELL & WRIGHT No. 3 *CAPSTAN LATHE.* 2in. bar capacity. Hand feed to turret and saddle. Spindle speeds 62 to 1,787 r.p.m. Complete with collet attachment, bar feed mechanism and other equipment. Motor drive 400/3/50. Price: £425

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VICTORIA Model U.2 Universal *MILLING MACHINE.* Table size 45in. × 11in. 12 spindle speeds 31 to 1,010 r.p.m. Complete with universal dividing head, vertical milling attachment, slotting attachment, 10in. dia. rotary table and electric suds pump. Motor drive 400/3/50. Price: £1,275

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PARKSON Model 2.J Universal *MILLING MACHINE.* Table size 4ft. 3in. × 11¼in. 12 spindle speeds 17 to 450 r.p.m. Power traverse to all table movements. With 6in. universal dividing head. Motor drive 400/3/50. Price: £875

CHURCHILL Plain Cylindrical *GRINDING MACHINE.* 6in. × 33in. between centres. Variable hydraulic feed to table. D.C. variable speed workhead. Max. wheel size 18in. dia. Motor drive 400/3/50. Price: £850

WARD No. 7 Combination *TURRET LATHE.* 14in. swing over bed × 33in. chuck to turret face. Spindle bored 2¾in. 8 spindle speeds 37 to 750 r.p.m. Power feed to turret and saddle. Motor drive 400-440/3-50. Price: £850

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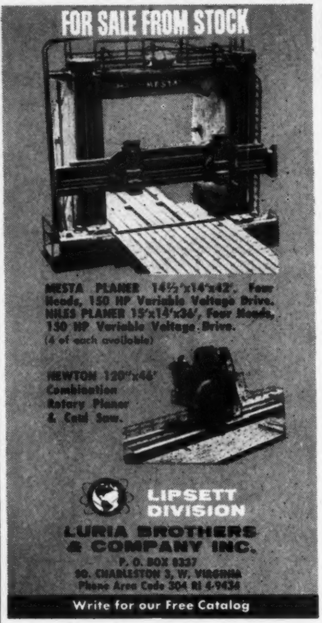

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BALLINGER Type C Abrasive Wheel Cut Off Machine. 2in. bar capacity, 3in. tubes. Pedal operated, swivelling vice, coolant. 400/3/50.

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ACME GRIDLEY type RAS.6 1in. capacity 6-spindle Automatic. Screwing and Drilling attachments. Excellent condition. 400/3/50.

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RUSHWORTH Geared, Overcrank, Power Guillotine, capacity 10ft. × ¼in. m.s. 20 strokes per minute. Motorised 15 h.p. 400/3/50. Complete with automatic hold-down, front and rear gauges, fully guarded and spare set of blades.

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Geared, inclinable, open fronted. With double roll feed, 8½in. rolls.
Variable stroke ½in. to 4½in.
With ejector and patent anti-deflector.
Safety Clutch. Tie bars. Fully Guarded.
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FOUR **BLACKBURN & CRAWSHAW** Rotary Shearing Machines. Motorised for 400/3/50 supply. Fitted with adjustable gauge. Capacity ¼in. thickness. Cutters 5½in. diameter × ¾in. thickness. Cutting speed 5ft. 6in. per minute. Weight approx. 10½ cwt.

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TWO NEW **LEN.** 25/220 High Speed Open Fronted Inclinable Power Presses. With adjustable stroke. Motorised for 400-440/3/50 supply. Pressure exerted 25 tons. Depth of throat 8$\frac{13}{16}$in. Table 16½in. × 22$\frac{1}{16}$in. Hole in table 8½in. Stroke adjustable from ¼in. to 3$\frac{1}{16}$in. Weight approx. 35 cwt.

BESCO Eccentric Power Punching Press. Motorised for 400-440/3/50 supply. Pressure exerted approx. 8 tons. Stroke adjustable from ½in. to 1½in. Bed 11½in. × 8¾in. Hole in bed 4½in. × 3¾in. Weight approx. 720 lb.

TAYLOR & CHALLEN Double Sided, Double Action Cam Action Drawing Press. Punch stroke 8in. Blankholder stroke 4in. Between uprights 20in. Bed 18in. × 15½in. Hole in bed 8in. diameter. Punch 4in. diameter. Hole in punch 1½in. diameter. Weight approx. 45 cwt.

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DENHAM Model DF8 8½in. centres on 9ft. bed S.S. & S.C. Gap Bed Lathe. Swing in the gap 31in. by 12½in. Fitted taper turning. Well equipped.

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MATTISON 36in. by 12in. Horizontal Spindle Surface Grinder. Hydraulic feeds up to 100ft. per min. Fitted 36in. by 12in. magnetic chuck, wheel size 20in. Motorised 15 h.p., 400/440 v., 3-phase, 50 cycles.

GLEASON No. 7 'REVEX' Bevel Gear Roughers, 14in. diameter by 4 d.p. on 2in. face, or 3–4 d.p., dependent on face width.

GENDRON Type 350-2000 14in. by 80in. between centres Universal Grinder.

HOLBROOK Model "R" No. 9 Universal relieving lathe, 9in. centres by 33in. b.c. Well equipped.

MANN Model FB1 Thread Miller, 14½in. swing by 54 b.c. cuts Metrics, Module, Whitworth and Diametral pitches.

SWIFT 15in. centres by 27ft. 6in. b.c. S.S. & S.C. lathe, fitted two saddles, taper turning.

KEARNS No. 2 Horizontal Boring and Facing machines, fitted verniers, facing head.

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SCHULER 32 Ton Ungeared, open fronted, inclinable, adjustable stroke ⅜in.-4in. (Three Available.)

LATHES

WARD No. 7 Combination turret. Covered bed. Power feeds. Chucking machine. Turret tooling.

DEAN, SMITH & GRACE 7in. Type 13Z S.S. & S.C. Lathe. Straight bed. 60in. between centres. Speeds (12) 29-889 r.p.m. Well equipped.

LANG 8½in. S.S. & S.C. Lathe. Gap Bed. 28in. swing in gap. 42in. between centres. Speeds (12) 12-600 r.p.m. Norton gear box. Well equipped.

SWIFT 9in. S.S. & S.C. Lathe. Gap Bed. 32in. swing in gap. 54in. between centres. Speeds (12) 14-500 r.p.m.

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MYFORD MG.12 Grinders.

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ARNO Millers.

BEAVER Millers.

ELLIOTT 7½in. Lathes.

HARRISON 8in. and **BOXFORD** Lathes.

MITCHELL 8½in. and 12½in. Lathes.

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SMART & BROWN 'A', '1024' Lathes, Toggle Presses & Screwing Machines.

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PROGRESS 4-spindle Multi-Spindle Drill comprising 2 ¾in. and 2 ¾in. Heads, complete with coolant equipment.
Complete range of Bench and Pillar Drills from ¼in. to 1in. cap. always in Stock.

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STARTRITE SABRE 300 Bandsaw with Butt Welding att.
WICKSTEED 6in. cap. Heavy Duty Hacksaw.
WICKSTEED 8in. cap. "Hydramatic" Heavy Duty Hacksaw.
INVICTA 6M 24in. stroke Shaping Machine (one machine standard, the other arranged for Automatic Down Feed, and with Swivel table).

MILLING MACHINES

VICTORIA V.3 Vertical Mill. Table size 60in. × 12½in. Rapid feeds all directions.
VICTORIA "Juniormil" Plain Horiz. Mill.
VARNAMO Model FU.2 Universal Mill. Table size 55in. × 13in. Rapid feeds all directions.
BEAVER VBRP Vert. Turret Mill. Table size 48in. × 10in. Fitted with 1½ h.p. motor. Power long. feed, and coolant equipment.

LATHES

SMART & BROWN Model L.16 Capstan Lathe.
MAS SV.18R 15in. Swing Precision Toolroom Lathe. Admits 48in. between centres.
WILLSON 7¼in. **NEWEL** Mark V S.S. & S.C. Lathe. On 7ft. bed, to admit 3ft. between centres.

GRINDING MACHINES

MYFORD MG.12 Cylindrical Grinding Machine.
UNION CARBIDE Tool Grinding and Lapping Machine. Complete with diamond wheels, lapping table and toolholder for chip breaker grooves.

PRESSES

WORCESTER 6-ton Large Daylight, Deep Throat Power Press.
DENBIGH Fly Presses, Size Nos. 2, 3, 4, 5 and 6.
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Collets and Tooling for **BRITAN** Repetition Lathes.
Multisize Collet Chucks by **F. BURNERD**.
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Replacement Hard and Soft Jaws for above chucks.
CLARKSON Autolock Collet Chucks.
Boring Heads, Dividing Heads, Rotary Tables, Suds Pumps, Machine Vices, Magnetic Chucks, **(FIMAX** and **ECLIPSE)**.

IN ADDITION TO THE ABOVE LISTED MACHINES WE HAVE MANY POPULAR MACHINE TOOLS DUE FOR DELIVERY BEFORE THE END OF THIS YEAR, AND SHOULD YOU NOT SEE THE MACHINE YOU REQUIRE IN THE ABOVE LIST PLEASE CONTACT US FOR DELIVERY INFORMATION.

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8½in. **CARDIFF** S.S. & S.C. Lathe, 48in. B.C.
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59in. × 16in. **CRAVEN** Victoria Milling Machine.
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New 51in. × 11½in. **LAGUN** Universal Milling Machine. Power feeds and rapids.
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No. 3 **GISHOLT** Bar Feed Capstan Lathe, with equipment.
No. 2 **WARNER & SWASEY** Capstan Lathe. Chucking.
43in. × 12in. **FRITZ WERNER** Vertical Miller. Swivelling head.
20in. **ARCHDALE** Plain Miller. Power feeds and rapids. Spindle speeds 60-1,230 r.p.m.
20in. **ARCHDALE** Plain Miller. Power feeds and rapids. Spindle speeds 30-615 r.p.m.
No. 3 **KITCHEN & WADE** Honer.
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11in./16in. **NOBLE & LUND** Hydraulic Cold Saw with Hydraulic clamp.
Model HBY **CHURCHILL** Electric Grinder.
14in. **BUTLER** Slotter. Power revolving table.
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No. 3 **KEARNS** Horizontal Borer.
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C. & G. OLDFIELD, LTD.
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Member of B.A.M.T.M.

No. 2 "Cincinnati" Dial-type Plain Milling M/c Table 52¾in. × 12½in. has 28in. long travel. 16 speeds 20-500 r.p.m. 5 H.P. 400-440/3/50 motor.—LEE & HUNT, LTD., Crocus Street, Nottingham. 'Phone: 84246.

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WICKMAN 5in. Chucking Automatic.
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KEARNS O B. Horizontal Boring Machine. 2¾in Spindle. Spindle Speeds 15/600 r.p.m. Excellent condition.
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ARCHDALE 8-Spindle Hydraulic Vertical Drilling Machine.

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LANDIS Universal Cylindrical Grinder, 12in. × 36in.
BROWN & SHARPE No. 5 Surface Grinder. 10in. throat.
BROWN & SHARPE No. 2 Surface Grinder, 18in. × 6in. table.
KELLER No. R6 Tool and Cutter Grinder.
HEALD No. 172 Gap Bed Internal Grinding Machine, maximum diameter of component 36in.

LATHES

N.D. 8in. × 6ft. S.S. & S.C. Lathe, 30in. between centres.
SMALLPIECE Lathe, type 6 WSLMS.
NOBLE & LUND Heavy Duty Centre Lathe. 22in. centre height × 29ft. between centres. Max. swing over saddle 33in. dia.
HARVEY Heavy Duty Centre Lathe. 42½in. centre height × 52ft. between centres. Max. swing over saddle 5in. dia.

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EDGWICK No. 2 Universal Milling Machine. Working surface of table 38in. × 7½in.
BROWN & SHARPE No. 3A Universal Milling Machine with Vertical Head Attachment. Spindle Speeds 30/1,200. Power feed all movements.
COLLET & ENGLEHARDT Keller Type Die Sinking Machine. Model FKf80 capacity 60in. × 30in.

PLANING MACHINES

CLEVELAND Openside Planing Machine, capacity 10ft. × 2ft. 6in.
CINCINNATI Planing Machine, capacity 8ft. × 2ft. 6in.

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it's ACORN 8881 for Machine Tools

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HERBERT No. 4 Capstan. Speeds up to 511 r.p.m. Well Equipped.

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LANG 10in. by 60in. S.S. & S.C. Lathe. 10-500 r.p.m. Spindle Bore 2¼in. 12½ h.p.

COLCHESTER Master 6½in. by 36in. Centre Lathe, Gap Bed, Ainjest Screwing, 57-1,000 r.p.m.

SWIFT Profile Copy Lathe. 18in. by 5ft. 6in. Speed Range 10-600 r.p.m. Excellent Condition.

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CINCINNATI 1-18 Production Mill.

KENDALL & GENT Vertical Mill. Table 19in. by 69in. Speed Range 20-300 r.p.m.

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NEW
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12in. dia. table, 3¼in. longitudinal stroke.
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UNIVERSAL Magnetic Chuck with effective area of 60in. × 7in.

All machines motorised 400/3/50

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ACORN Hi-Lo ¾" Capstan.
DENBIGH D 4 Uni. Mill.
CENTEC 2 B Uni Mill.
PROGRESS 16, 1S, 2a, 3a.
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"Magdeburg" All Geared Lathe 12in. Centre, 12ft. between centres, swing in gap 33in. £1,400
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FOR EARLY DELIVERY

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Spindle speeds up to 40,000 r.p.m. approx.
Finger touch controls.
Convert to a surface grinder in under 10 minutes.
Complete lack of vibrations.
A precision machine for the precision engineer.

CAPACITY:
Cylindrical Grinding

Max. dia.	8in.
Max. centre distance	7in.
Table angulates plus or minus	5°
Table traverse	10in.
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Crossfeed coarse traverse graduations in .000225in. .05625in. per rev	
Crossfeed fine traverse graduations in .00005in. .0125in. per rev	
Vertical spindle feed, max.	2½in.
Vertical feed per revolution of handwheel	.125in.
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DEMONSTRATION CAN BE ARRANGED AT WORKS

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INVICTA 4M, 18in. Shaper.
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Leading Plastics Company in SURREY, invites applications from capable Technical Staff for appointments in Estimating, Prdouction Methods and Work Study departments.

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AGE 25-35. PROGRESSIVE SALARY.

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Machine Tool Manufacturers and Production Consultants engaged in the supply and installation of modern automatic production machines and equipment, require a Production Engineer, aged about 30, for technical liaison and sales. Good opportunity for all-rounder to use his initiative:

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Desirable: Some knowledge of German or Italian.

London base. Salary commensurate with experience, plus car and expenses, offered to successful applicant.

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Sales Engineer Required For Machine Tool Company in London. Duties concern correspondence, quotations, production estimates and sales promotion for lathes, including capstans, automatics and production centre lathes. Commensurate previous experience essential. State age, education, apprenticeship, experience, with details of each previous employment, present salary and salary required.—BOX D277, MACHINERY, Clifton House, Euston Road, N.W.1.

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WANTED URGENTLY—
CHURCHILL 'BD' Brake Drum Grinder or equivalent.
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WANTED—
LARGE CENTRE LATHE
Age and condition not vital. Should be 72in. to 84in. Dia. Swing or capable of having centres packed up to meet this height. Distance between crs. 12ft. 0ins. to 20ft. 0ins.
LAURENCE, SCOTT & ELECTROMOTORS LIMITED,
Gothic Works, Norwich (Ref. GLB)

CLUSTER DRILLS No. 3
M.T. up to 24 adjustable spindles
Pidgen Brothers Ltd.,
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Secondhand Heavy Duty Shear-ing Machine capable of cutting 2ft. 6in. × 2ft. 6in. Sheet Copper 1in. thick and Steel Bar 1in. × ½in. Shear blades to be set parallel with machine and throat depth to be approx. 12in. Motor drive to be suitable for 400/440 volts, 3 phase, 50 cycles supply.—BOX D300, MACHINERY, Clifton House, Euston Road, N.W.1.

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INDEX TO ADVERTISERS

(Continued on page 190)

INDEX TO ADVERTISERS—*(continued from page 189)*

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